SmartPilot S1 Wheel & Tiller

Service Manual

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Important Information

Safety notices

CAUTION: Electrostatic discharge

The S1(G) course computer contains electrostatic sensitive components. Always observe the appropriate precautions when handling, shipping and storing this product. Failure to do so could result in permanent damage to the equipment.

CE marking of equipment/replacement parts

If the Raymarine equipment under repair, test, calibration, installation or setting to work carries the European CE mark, only parts and components supplied or approved for such use by Raymarine should be used in order to maintain compliance with the relevant CE requirements.

Incorporation, use or attachment, by any means, of parts or components not supplied or not approved for such use by Raymarine or, if supplied or approved for use by Raymarine, not properly fitted in accordance with instructions published, provided or recommended by Raymarine, may cause the equipment to malfunction and in particular, to become unsafe or to no longer meet the relevant CE requirements. In these circumstances, Raymarine excludes liability to the fullest extent permissible in law for any loss or damage including any liability for its contribution to such loss or damage by its negligent acts or omissions.

EMC conformance

All Raymarine equipment and accessories are designed to the best industry standards for use in the recreational marine environment.

The design and manufacture of Raymarine equipment and accessories conform to the appropriate Electromagnetic Compatibility (EMC) standards, but correct installation is required to ensure that performance is not compromised.

Waste Electrical and Electronic (WEEE) Directive

The WEEE Directive requires the recycling of waste electrical and electronic equipment. Whilst the WEEE Directive does not apply to some of Raymarine's products, we support its requirements as par t of our environmental policy and we ask you to be aware of how you should dispose of this product. The crossed out wheelie bin symbol found on our products signifies that it should not be disposed of in general waste or landfill. Please contact your local dealer, national distributor or Raymarine Technical Services for information on product disposal.

Technical accuracy

The technical information contained within this Service Manual, to the best of our knowledge, was correct at the time of writing. However, Raymarine cannot accept liability for any inaccuracies or omissions it may contain.

In addition Raymarine's policy of continuous product improvement may change specifications without notice. As a result Raymarine cannot accept any liability for any differences between the product and the manual.

Warranty

This unit contains no serviceable parts, if the unit has failed replace PCB or rate gyro as necessary.

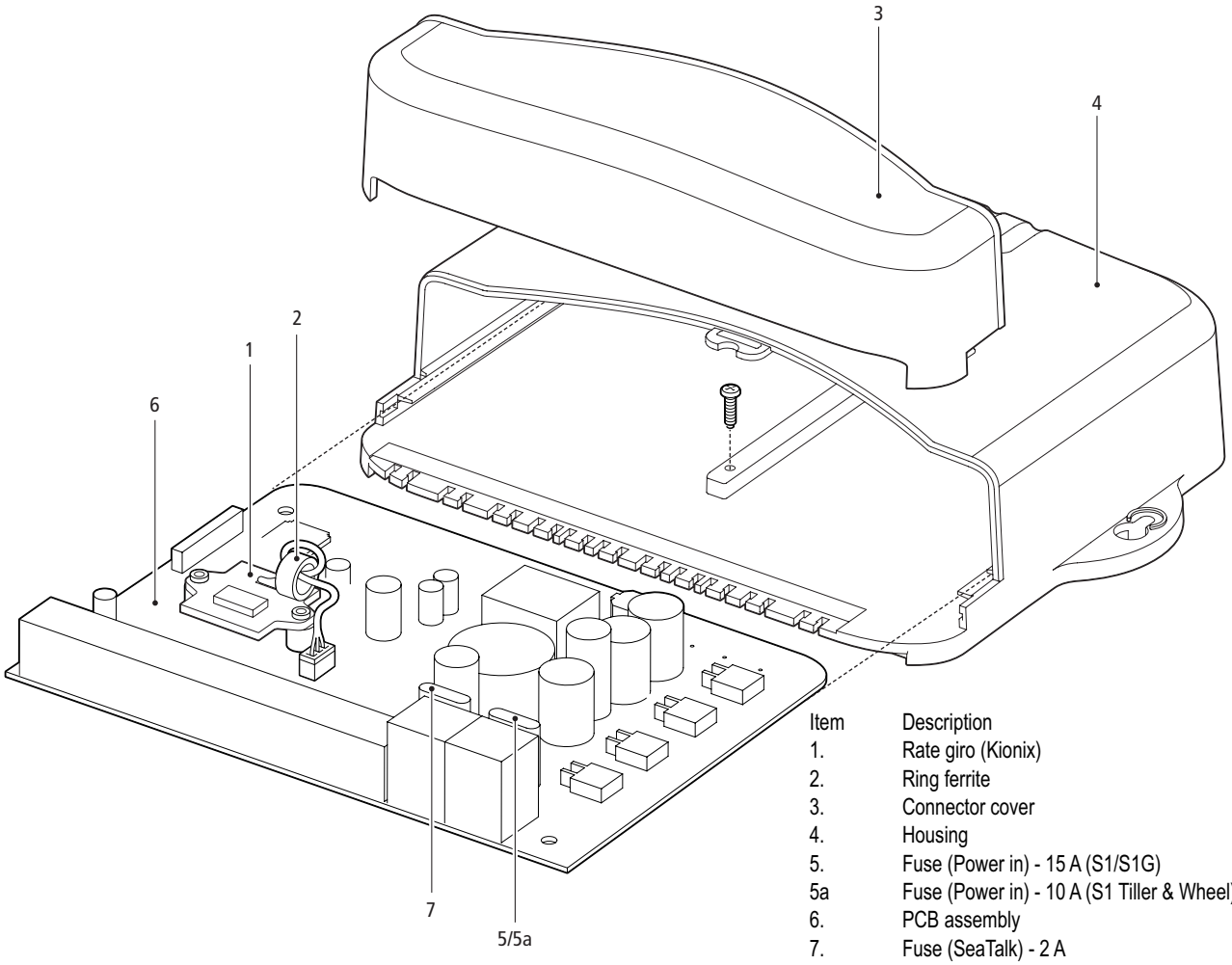
Introduction

This manual describes the service and maintenance procedures for the Raymarine type S1 and S1G Course Computer.

General description

The Course Computer processes information from the sensors in the autopilot system so it can steer the boat using the drive unit. The Course Computer assembly consists of a plastic case, a printed circuit board (PCB). The PCB carries a microprocessor, electronic circuitry to control the drive unit, a power amplifier for the drive motor and a connector block for all inputs and outputs.

Type S0/S1G assembly drawing



Item	Description
1.	Rate giro (Kionix)
2.	Ring ferrite
3.	Connector cover
4.	Housing
5.	Fuse (Power in) - 15 A (S1/S1G)
5a	Fuse (Power in) - 10 A (S1 Tiller & Wheel)
6.	PCB assembly
7.	Fuse (SeaTalk) - 2 A

Spares

Item	Spare /Accessory	Part Number	Comments
3 4	Connector cover Housing		
5 5a 7	Fuse 15 A (S1 & S1G) Fuse 10A (S0 Tiller & Wheel) Fuse 2 A		
6	PCB		less gyro
1	Gyro	A18069	Kionix - from Aug. 2005 (Revision E PCBs)

Functional tests

Introduction

This section describes how to complete basic functional tests on the Course Computer aiding fault diagnosis.

Equipment and tools

- ST6001/2 Control Head
- Rudder Reference (*Not applicable to Verado or Tiller pilot versions*)
- Fluxgate Compass
- C/E Series unit
- DVM (Digital Volt Meter)
- 12V dc 10A PSU (*Power Supply Unit*)
- Type 1 pump
- A conventional 330 Ohm resistor, rated at 1 Watt

Initial inspection checks

Before applying power to the Course Computer carry out following visual inspections:

1. Remove the connector cover, the PCB retaining screw and slide the PCB out of the case.
1. Check that the two fuses, F1 (15A), F2 (2A) are the correct rating and not blown.
2. Visually inspect the PCB for any obvious signs of component damage or blackening, paying particular attention to the FETs and main power components.
3. Check that capacitor C43 polarity is correct (*see Tech Update TU228*)
4. Check that resistance value of R18 matches the requirement of the gyro fitted *(see Tech Update 332*)

Rate gyro connection

The plug is designed to fit one way into the socket. Check the plug is correctly inserted and fully seated.

Detailed diagnosis

Before starting testing ensure that the following are connected to the Course Computer:

- Fluxgate compass
- Rudder reference (*Not applicable to Verado or Tiller pilot versions*)
- Control Head
- 330 Ohm resistive load to the clutch terminals(*S1 Only! Not applicable to S0 Tiller & Wheel pilot versions*)
- C/E Series display connected via NMEA 0183. **Do not connect the C/E Series unit via SeaTalk!**

Unless otherwise stated, the following tests should be carried out with 12V applied to the Course Computer.

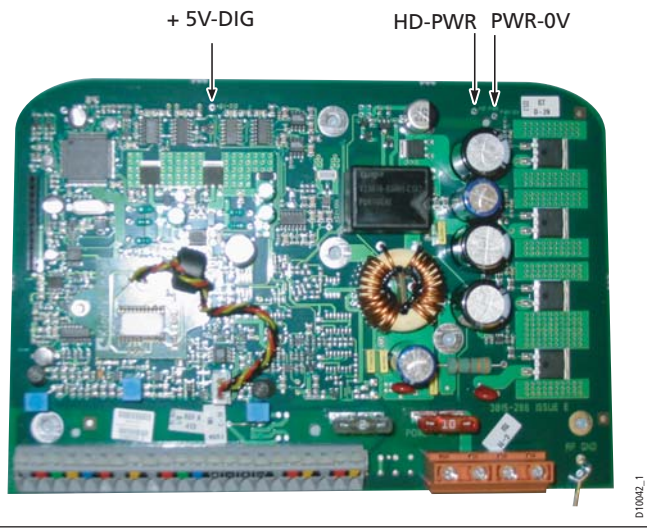
If the unit fails any of the following diagnostic checks (except Step 3), return the PCB to Raymarine and obtain a service exchange unit. Component level replacement must only be carried out by the factory.

Step 1 - Power checks

Check the voltages at the following locations are correct:

Test point	Voltage
+5V-DIG	4.9 V - 5.1 V
HD-PWR	11.95 V - 12.05 V
PWR-0V	0 V

Voltage test-point locations



Step 2 - System checks

1. Check that the display shows a compass heading (the actual heading displayed is unimportant at this stage) and that a rudder angle bar is displayed. This confirms that the Seatalk communications are functioning correctly.

Note: *From October 2005 revision E PCB s have Verado software installed. This software does not require an external rudder reference device. In standby mode the rudder reference bar will not be displayed.*

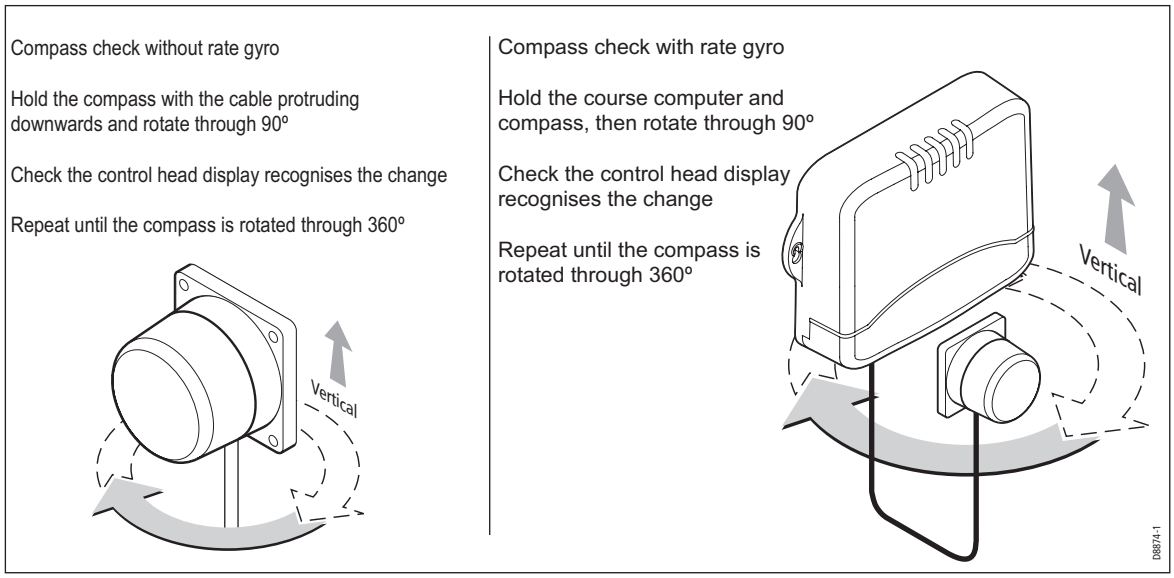
Step 3 - Rate gyro

1. Using a DVM, measure the voltage at the rate gyro terminals (black and yellow leads). If the rate gyro is serviceable, the nominal reading is 2.5 V ± 0.1 V.
2. With the multi meter still connected, turn the Course Computer slowly, first clockwise, then anticlockwise.
3. If the rate gyro unit is functioning correctly, the voltage should increase (from 2.5V) as the Course Computer is turned in one direction and decrease (from 2.5V) as it is turned in the opposite direction.

If the signal levels are unstable or outside tolerances, replace the gyro (Refer to Tech Update TU232).

Step 4 - Compass

1. With the compass unit connected to the Course Computer, rotate the compass through 90º as shown below.
2. Slowly rotate the compass clockwise through 360º. As the compass is turned, check that the displayed heading increases with no sudden changes in the reading (If the rate gyro is fitted, also rotate the Course Computer).


Compass check without rate gyro
Hold the compass with the cable protruding downwards and rotate through 90º
Check the control head display recognises the change
Repeat until the compass is rotated through 360º
Vertical
Compass check with rate gyro
Hold the course computer and compass, then rotate through 90º
Check the control head display recognises the change
Repeat until the compass is rotated through 360º
Vertical
D8874-1

Note: *Ensure that you hold the compass with the cable protruding downwards.*

Step 5 - Rudder Reference (*Not applicable for Verado & Tiller Pilots*)

1. Check that the rudder offset value is set to zero. (To adjust, use the Dealer Calibration screens.)
2. Move the rudder reference into the central position.
3. Check that the rudder bar on the display is in the central position.
4. Move the rudder reference to the left and check that the rudder position bar on the display moves to the left.
5. Move the rudder reference to the right and check that the rudder position bar on the display moves to the right.

Note: *If the rudder bar display moves the wrong way, turn off the power, reverse the red and green wires connected to the RUDDER inputs on the Course Computer, switch on the power and re-check.*

Step 6 - Clutch - Auto (*Not applicable to S1 Tiller & Wheel*)

1. Ensure that the rudder reference is in the central position.
2. Press **AUTO**
3. Measure voltage at clutch terminals (12 V nominal), then proceed to step 7.

Step 7 - Clutch - Standby (*Not applicable to S1 Tiller & Wheel*)

1. Press **Standby**
2. Measure voltage at clutch terminals. If the voltage is 0 V, proceed to step 8.

Step 8- H-Bridge

1. Press **AUTO.**
2. Press **+10** twice, the motor should spin.
3. Press **STANDBY,** the motor should stop.
4. Press **AUTO**
5. Press **-10** twice, the motor should spin in the opposite direction
6. Measure HD-PWR whilst the motor is running (Check this against the table in Step 1).

Step 9 - NMEA

RECEIVE

1. Enter a new waypoint into the C/E Series unit.
2. Perform a "Goto Waypoint" command on the C/E Series unit.
3. Verify that the waypoint information has been sent to the Course Computer by viewing the XTE, DTW and BTW data pages on the Control Unit.

TRANSMIT

Check that the heading displayed on the C/E Series unit matches that of the Autopilot.

Step 10 - EEPROM Test

This test checks that the calibration settings are being stored correctly.

1. Using the calibration screens, change the Drive Type to a different value.
2. Save the setting and exit calibration.
3. Remove and re-instate power to the Course Computer.
4. Verify that the new drive type is still active.

Disassembly and reassembly

CAUTION: Electrostatic Discharge (ESD)
This product contains components that can be damaged by electrostatic discharge.
If the cover is removed, any work on the product must be carried out at a properly equipped anti-static station by personnel wearing anti-static straps.

Tools required

To assemble/disassemble the Course Computer you will need:

- 3 mm Allen key
- cross-head screwdriver

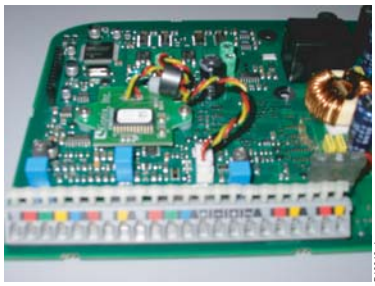
Disassembly/reassembly

Remove the connector cover

Remove the PCB retaining screw

Slide out the PCB

Unplug the rate gyro connector from the PCB



Remove the gyro retaining screws on the rear of the PCB (retain the screws and plastic pillars)

Software

Software history

Version	Change
4.58	S1 Tiller & Wheel pilot release version.

Software upgrade

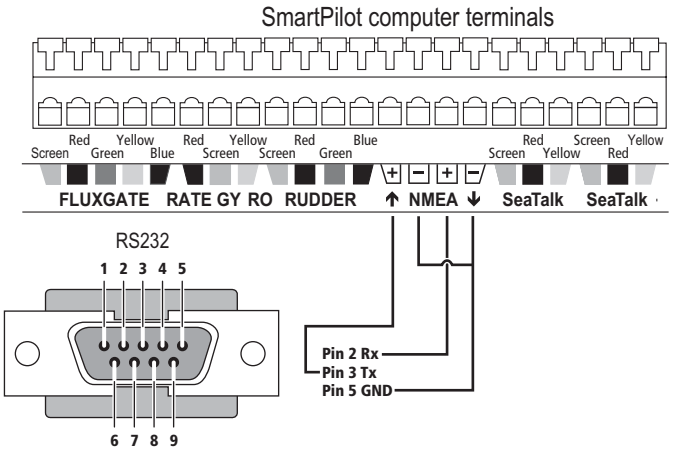
The Type S1(G) Course Computer has the ability to implement software upgrades via the NMEA port connected to a PC running Windows 9x or NT 4.0. This section describes the upgrade procedure.

A PC or laptop with an RS232 port is required, together with a custom serial download cable.

The laptop software comprises three files plus the downloadable file.

Note: *It is very important that during the actual file transfer that power is not removed from the Course Computer. If power is lost, only a partial transfer will take place and will render the unit inoperable. In this case the unit will have to be returned to Raymarine.*

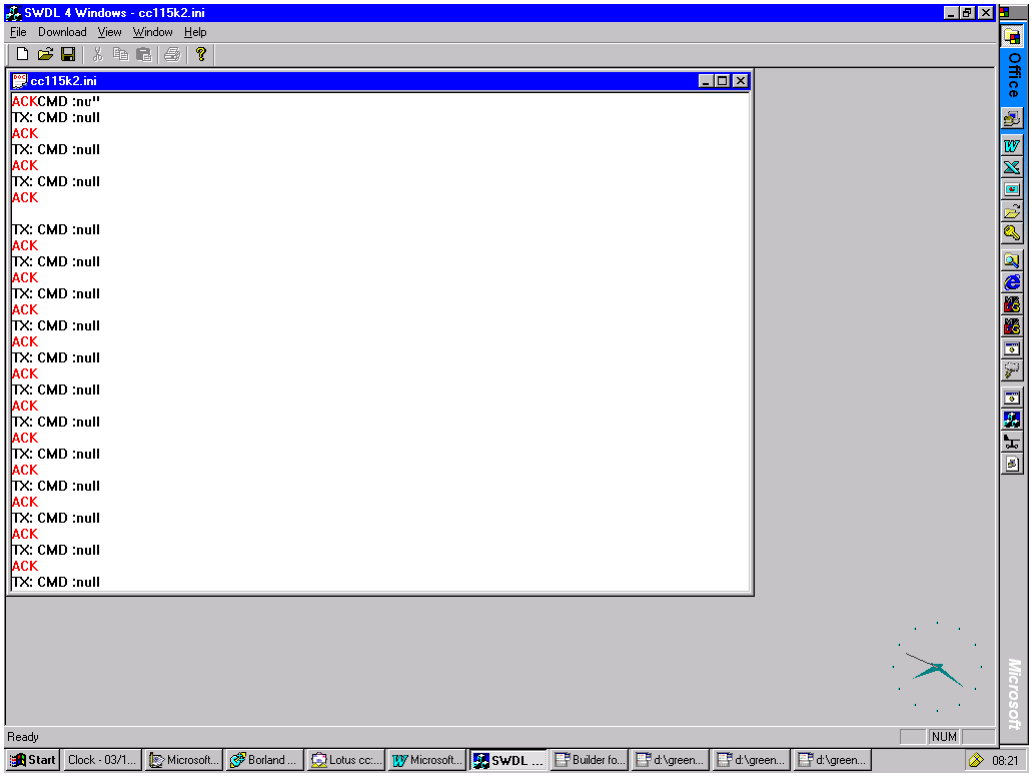
RS232 connections



Download procedure

1. Power Off the Course Computer and connect a cable as shown to the PC's serial port.
2. From the PC, run the programme **SWDL 4 Windows.exe.**
3. From the menu select **File>Open CC115K1.INI** if using com port 1 **or CC115K2.INI** if using com port 2.
4. Power Up the Course Computer. You should now see RED and BLACK messages on the scrolling down the screen.

5. Make sure that every other line is a red ‘ACK’ as shown below. If it is not, power off the course computer and then power it on again.



6. Select **Download** and click on **Download application**.
7. In the dialog box, select *.BIN file required for download.

CAUTION: **DO NOT SWITCH OFF POWER TO THE COURSE COMPUTER DURING THE FILE DOWNLOAD!**

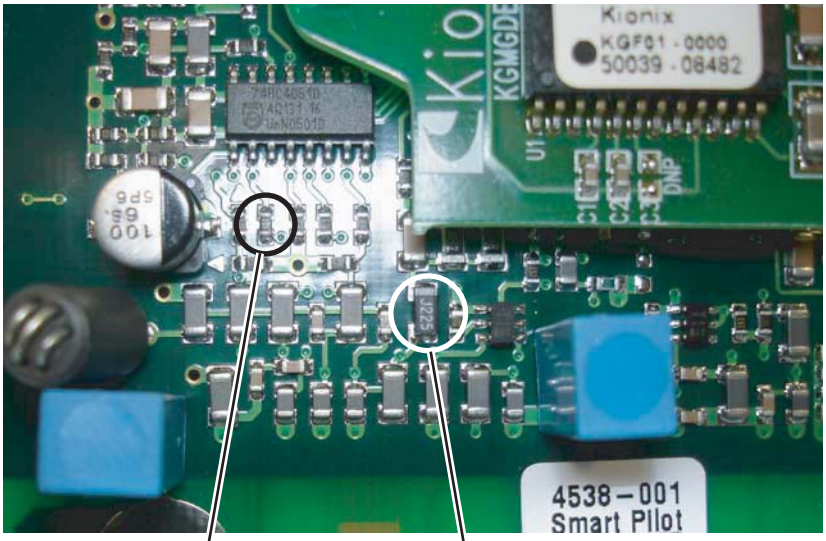
8. The Download will take 30 seconds to 1 min and the message **Download Successful** will be displayed.
9. Power OFF the Course Computer and disconnect the download cable.
10. The software upgrade is now complete and the Course Computer is ready for use.

Product history

Technical updates

Update	Title
TU228	Fluxgate Compass Circuit Fault
TU232	Introduction of new “Kionix” Rate Gyro module
TU240	Crystal Oscillator CCT Capacitor
TU245	Introduction of V4.37 Software
TU257	Withdrawal of V4.37 Software
TU266	Kionix Gyro Heading drift fault
TU267	Release of V4.58 Software

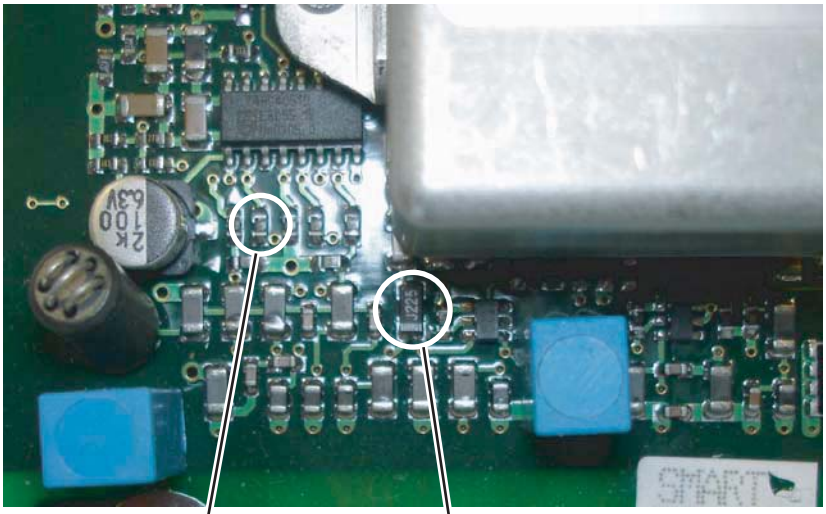
PCB 3015-286 issue E (Aug 05)



Ref: Tech note TU232
resistor value 113k (Kionix gyro)

Ref: Tech note TU228
capacitor correctly orientated

PCB 3015-286 issue A to E



Ref: Tech note TU232
resistor value 110k (Murata gyro)

Ref: Tech note TU228
capacitor incorrectly orientated

Technical Update

Issue Number: TU228
Page **1** of **2**
Date: 1st August 2005
Author: **Bob Sims**

Product Description:	**SmartPilot S1 & S1G Course Computers, Corepacks & Systems**
Serial Number(s):	**All**
Subject:	**Fluxgate Compass Circuit Fault**

Please be advised that infield feedback has highlighted a potential fluxgate compass circuit fault, which can affect current S1 and S1G SmartPilot course computers.

The fault will cause the compass heading to drift, jump segments or show large inaccuracies.

The fault is associated with the wrongly reverse placement of the fluxgate drive AC coupling capacitor C43. The fault does not affect all S1 Course Computers and is only triggered when the tolerance of the capacitor is at the limits of its value specification.

The following service procedure should be taken to rectify faulty units:

- Follow procedure over.
- Remove PCB from Course Computer Case
- Locate C43 Capacitor
- Unsolder & remove from PCB
- Replace and re-solder in reverse (see diagrams)
- Replace PCB into case
- 15mins labour per unit can be claimed against warranty
- For onboard service follow the normal warranty claims procedure

For further information contact Raymarine's Technical Services Department.

Priority:	**Distribution List:**
✓ **URGENT** *(For immediate attention)*	✓ **Distributors & Service Agents**
ROUTINE *(Action at next Service Call)*	✓ **Installing Agents & BoatBuilders**
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Raymarine,
Raymarine House,
Quay Point,
Portsmouth,
Hampshire,
PO6 3TD, UK.
T: +44 (0)23 9269 3611 ext 2023
F: +44 (0)23 9266 1228

Raymarine Inc.,
21 Manchester Street
Merrimack, NH 03054-4801
USA
T: 1-603-881-5200
F: 1-603-864-4756
www.raymarine.com

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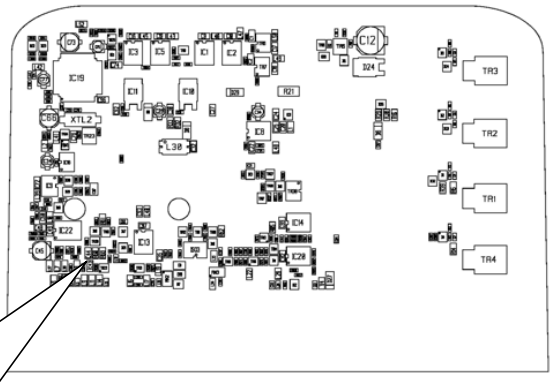
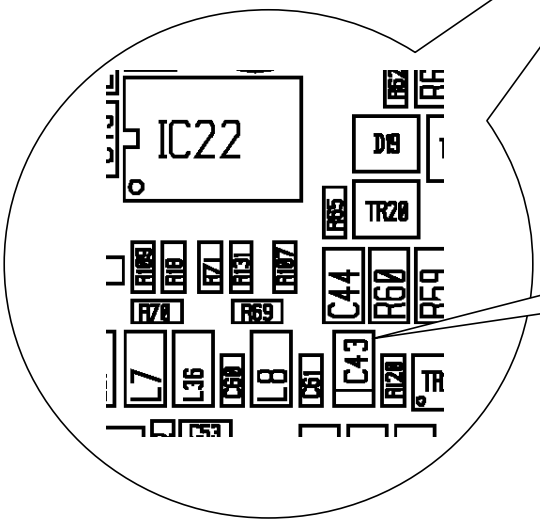
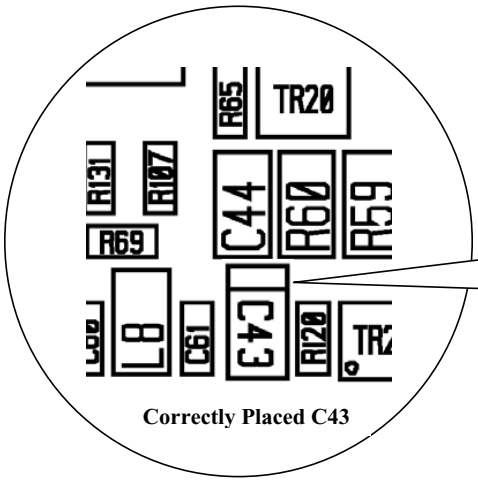
Service Details and Procedures





C43 Polarised Capacitor 2.2uF 6.3v
Wrongly Placed on PCB!



Correctly Placed C43

Service Procedure:

- Remove PCB from plastic casing
- Locate C43 Capacitor
- Unsolder & Remove from PCB
- Replace & re-solder in reverse

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Technical Update

Issue Number: TU232
Page **1** of **2**
Date: 19th September 2005
Author: Bob Sims

Product Description:	**SmartPilot S1G, S2G, S3G**
Serial Number(s):	**S1G – E12115 – 0850001** **S2G – E12091 – 0850001** **S3G – E12092 – 0850054** **S3G IPS – E12177 - 0850003**
Subject:	**Introduction of new "Kionix" Rate Gyro module**

Due to obsolescence of the earlier Murata type Gyro, a new Rate Gyro module (Kionix) has now been introduced into production SmartPilot Course Computers. The list above indicates start serial numbers.

Improved high speed Performance:
The introduction of the Kionix Gyro will in some cases improve the high speed steering performance of vessels fitted with the G version pilots.

Service Requirements - Course Computer back compatibility:
The application of the new Kionix gyro requires a modification to early Course Computer PCB's by way of a change of resistor values. (See diagrams).

Resistor & Gyro Consignment:
S1G:
Surface mount Resistor (R18) fitted:
Murata Gyro – R18 = 100k (0603)
Kionix Gyro – R18 = 113k (0603)

S2G / S3G:
Surface Mount Resistors (R145 & R147) fitted:
Murata Gyro – R145 & R147 = 10k (0805)
Kionix Gyro – R145 & R147 = 11.3k (0805)

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Raymarine plc (UK)
Tel. +44 (0)23 92693611 (ext.2023)
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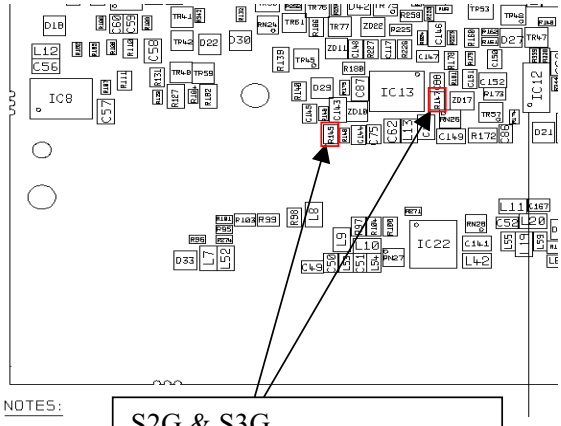
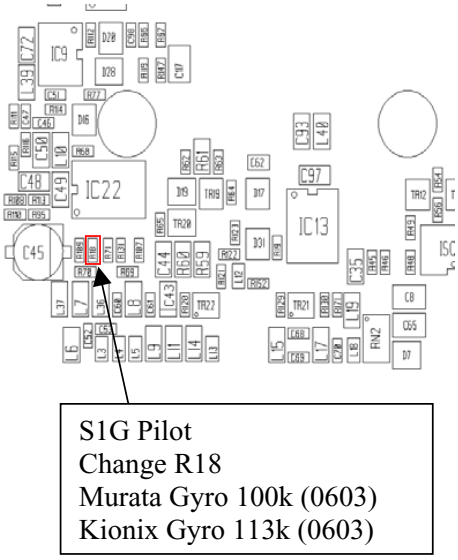
Kionix Gyro (new)

Murata Gyro (early)

S2G & S3G SmartPilot PCB



S1G SmartPilot PCB



Gyro assembly onto PCB:
The new Kionix Gyro is mounted onto the PCB in the same orientation as the Murata Gyro. With the Course Computer upright (connector strip at the bottom), the Gyro should be secured to the PCB with the Gyro loom & connector uppermost.

Replacing faulty Murata Gyro with new Kionix Gyro on early Course Computer PCB:
S1G - Replace R18 with 113K Resistor, secure and connect Gyro as above.
S2G/S3G/150G/400G - Replace R145 & R147 with 11.3K Resistor, secure and connect Gyro as above.

Replacing faulty Course Computer PCB with new modified PCB and retaining early Murata Gyro:
S1G – Replace PCB and change R18 with 100K Resistor secure and connect Gyro as above.
S2G/S3G/150G/400G – Replace PCB and change R145 & R147 with 10K Resistor, secure and connect Gyro as above.

Service Spares:
Gyro service spares will be supplied with the appropriate resistors, therefore it is strongly recommended to check resistor values against the Gyro type when servicing the Course Computer.

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Technical Update

Issue Number: TU240
Page **1** of **2**
Date: 14th December 2005
Author: Bob Sims

Product Description:	**S1 / S1G and S1000 SmartPilot Course Computers**
Serial Number(s):	**Jan 06**
Subject:	**Crystal Oscillator CCT Capacitor change**

Warranty return failure code data has highlighted a potential Seatalk Circuit failure on the S1 / S1G and S1000 SmartPilot systems, resulting in the following failure modes:

Seatalk 1 fail message "No Link" displayed on the Autopilot Control unit.
Seatalk 1 fail message "Seatalk Fail" displayed on the Autopilot Control unit.
The Seatalk 1 bus (system) not functioning.
Other Seatalk 1 Displays may not be receiving or transmitting data.
Loss of Seatalk GPS on S1000.

Our Engineering Team have discovered the problem to be associated with the Crystal Oscillator circuit causing the Processor to stop running.

A solution has been found which entails a modification to the circuit in the form of two Capacitor value changes. The circuit change is described in detail below and over:

Circuit Modification:

S1 / S1G Course Computer:
Change Surface mount Capacitor C78 from (47pF) to (22pF) – (type 0603, 50v, 5%)
Change Surface mount Capacitor C79 from (68pF) to (22pF) - (type 0603, 50v, 5%)

S1000 Course Computer:
Change C97 from (47pF) to (22pF) - (type 0603, 50v, 5%)
Change C98 from (68pF) to (22pF) - (type 0603, 50v, 5%)

DISTRIBUTION LIST:	INFIELD ACTIONS:
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Raymarine plc (UK)
Tel. +44 (0)23 92693611 (ext.2023)
ukproduct.support@raymarine.com
www.raymarine.com

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Tel. 1-603 881 5200
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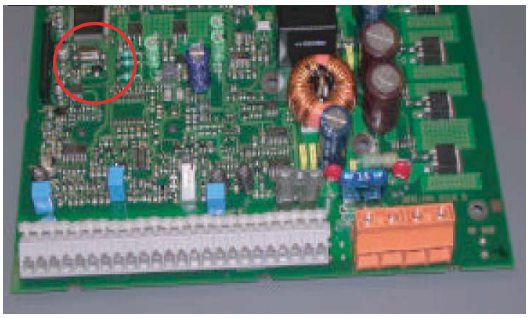
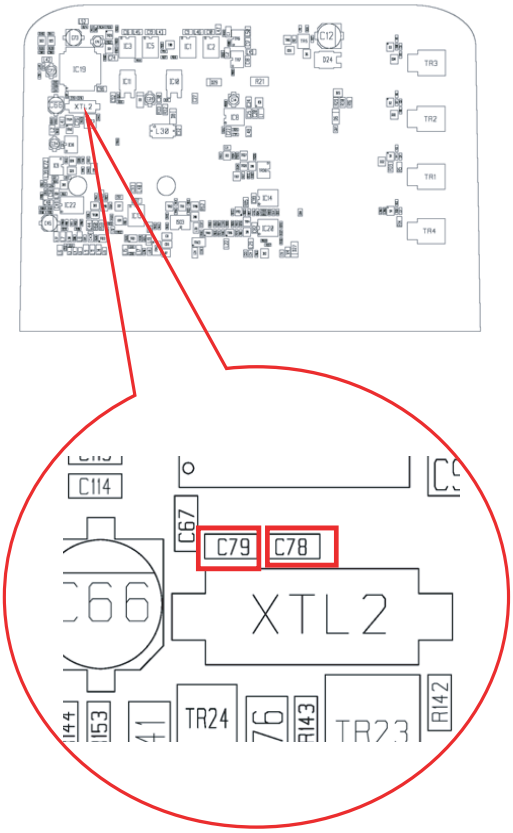
S1 / S1G Course Computer Circuit Modification

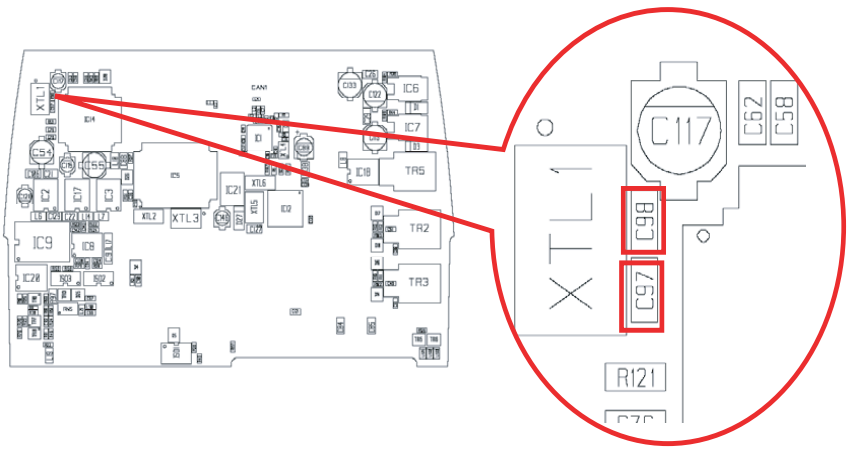




Change Capacitor C78:
From 47pF to 22pF

Change Capacitor C79:
From 68pF to 22pF

S1000 Course Computer Circuit Modification



Change Capacitor C97:
From 47pF to 22pF

Change Capacitor C98:
From 68pF to 22pF

Technical Update

Issue Number: TU245
Page **1** of **1**
Date: 1st April 2006
Author: Bob Sims

Product Description:	**S1G Verado SmartPilot** **All S1 and S1G SmartPilot systems** **S1 and S1G Core Packs** **S1 and S1G Course Computers**
Serial Number(s):	**S1G Verado SmartPilot – (0260001)** **S1 Systems – (0260055), S1G Systems–(0260107)** **S1 & S1G Course Computers (0260027)**
Subject:	**Introduction of V4.37 Software**

With the introduction of the new Verado SmartPilot we have consolidated the new software version (V4.37) across the whole range of S1 and S1G SmartPilot systems.

Features and Enhancements:

Improved course keeping in TRACK mode:

There is no change in the initiation of Track mode. When Track is entered the SmartPilot will bring the boat onto track in a controlled way. The closer the boat is to the correct heading and track the quicker and smoother it will settle the boat onto the new course.

Dodge Control in Track mode:

If a dodge manoeuvre is initiated by using the course change keys or rotary control the pilot will revert to Auto mode. Once safely past the obstacle, Track mode can be reinitiated onto the route.

Turn Rate Limit control:

The Turn Rate Limit can be used to adjust the Pilots rate of turn onto track and maintaining course. Thus increasing or decreasing the aggressiveness of the turn.

Operational Anomaly:

There is currently a problem with this level of software whereby the Pilot if switched into Auto mode within 30 seconds of power up will trigger a “No Data” & “Start Up” fault message and alarm. This only effects the pilots operation within this 30-second period in which the software searches for a Rate Gyro. The Pilot will operate correctly at all times after this period. Corrective software will be released in due course.

The software can be uploaded in the normal way using a PC or Lap Top running the Programming utility (SWDL4.exe) and connected to the S1 Course Computer via a 9 pin D type Serial cable.

The software will be accessible from the Dealer area of the WEB site and from the Technical Services FTP site.

DISTRIBUTION LIST:	**INFIELD ACTIONS:**
☐ INTERNAL RELEASE	☐ INFORMATION ONLY
☐ DISTRIBUTOR & SERVICE AGENT	☐ ACTION AT NEXT SERVICE
☐ INSTALLING AGENTS	☐ HOLD DEALER STOCK
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www.raymarine.com

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Technical Update

Issue Number: TU266
Page **1** of **1**
Date: 16th November 2006
Author: Bob Sims

Product Description:	**All Gyro version SmartPilot Course Computers and Smart Heading sensors:** **S1G, S2G and S3G Core Packs and Course Computers** **S1000 Entry Level Pilot Course Computer** **Smart Heading Sensor**
Serial Number(s):	**From November 2006 production onwards (1160001)**
Subject:	**Kionix Gyro Heading Drift fault**

Investigation of warranty data has highlighted a potential fault on Gyro version Autopilots and the Gyro Smart Heading Sensor. – Products effected listed above.

The fault is associated with a batch of faulty Gyro chips that drift at start up causing the heading to drift and show an offset of typically between 3 to 30 degrees heading error. The resultant fault could cause poor autopilot performance and inaccurate displayed heading.

All the Kionix Gyro chips are marked with a serial number, those prior to (50080-XXXXX) are potentially faulty and will need to be replaced. It is suspected that units produced between January 2005 and November 2006 may be effected. All Gyro modules after (50080-XXXXX) perform to specification.

Raymarine has bonded and reworked all the above products and spare stock and now only manufacture with the correctly specified Kionix Gyro.

Products affected in the field should be upgraded to the correctly specified Gyro using the Gyro module spare part (A18069) - this will improve the performance. A longer-term software solution will be available within Q1 of 2007.

DISTRIBUTION LIST:	**INFIELD ACTIONS:**
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D10053_1

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Technical Update

Issue Number: TU267
Page **1** of **1**
Date: 1st January 2007
Author: Bob Sims

Product Description:	**S1G Verado SmartPilot** **All S1 and S1G SmartPilot systems** **S1 Tiller and Wheel Systems** **S1 and S1G Core Packs** **S1 and S1G Course Computers**
Serial Number(s):	**From January 2007 production (0170001)**
Subject:	**Release of Version (V4.58) Software**

Following on from (TU257) where due to technical problems highlighted from warranty feedback the software version (V4.37) was withdrawn and all S1/S1G SmartPilots reverted back to (V3.04).

We have now consolidated and introduced the new production software version (V4.58) across the whole range of S1 and S1G SmartPilot systems, Core Packs and Course Computers. This level is also included in the new S1 Tiller and Wheel SmartPilots.

The software can be uploaded in the normal way using a PC or Lap Top running the Programming utility (SWDL4.exe) and connected to the S1 Course Computer via a 9 pin D type Serial cable.

The software will be available from Raymarine Product Support and accessible via the Dealer area of the WEB site and from the Technical Services FTP site.

The following table lists the software enhancements and bug cures that have been included:

DISTRIBUTION LIST:	**INFIELD ACTIONS:**
☐ INTERNAL RELEASE	☐ INFORMATION ONLY
☐ DISTRIBUTOR & SERVICE AGENT	☐ ACTION AT NEXT SERVICE
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☐ BOATBUILDER	☐ REWORK DEALER STOCK
☐ KEY STOCKIST	☐ RECALL DEALER STOCK
☐ POST on WEB	☐ RECALL CUSTOMER PRODUCT

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D10054_1

Software Bug and Enhancement:	Software Effected:	Software Cured:
NMEA Input data bridging fault – Waypoint Tracking data not bridged onto the Seatalk data bus	V4.37	V4.58
Start Up and No Data displayed within 30 seconds of Auto	V4.37	V4.58
No Speed indicated if NMEA is connected to a Control unit	V4.37	V4.58
Intermittent loss of Rudder Bar	V4.37	V4.58
Poor Tracking to Waypoint – Pilot steers 30 degrees off course	V4.37	V4.58
Intermittent Drive Stopped message and Off course Alarm in Auto Tack	V4.37	V4.58
Improved software for Kionix Gyro start up – To cure compass drift: - Pilot software now waits 30 seconds before reading the Gyro	V3.04 / V4.37	V4.58
RC435 NMEA Tracking Fault cured	V4.37	V4.58
General improved Tracking to Waypoint algorithm	V3.04 / V4.37	V4.58
Can effect RS125 GPS Filtering	V4.37	V4.58
Can operate without a Rudder Reference Transducer for the Verado and Tiller SmartPilot	V3.04	V4.37 / V4.58

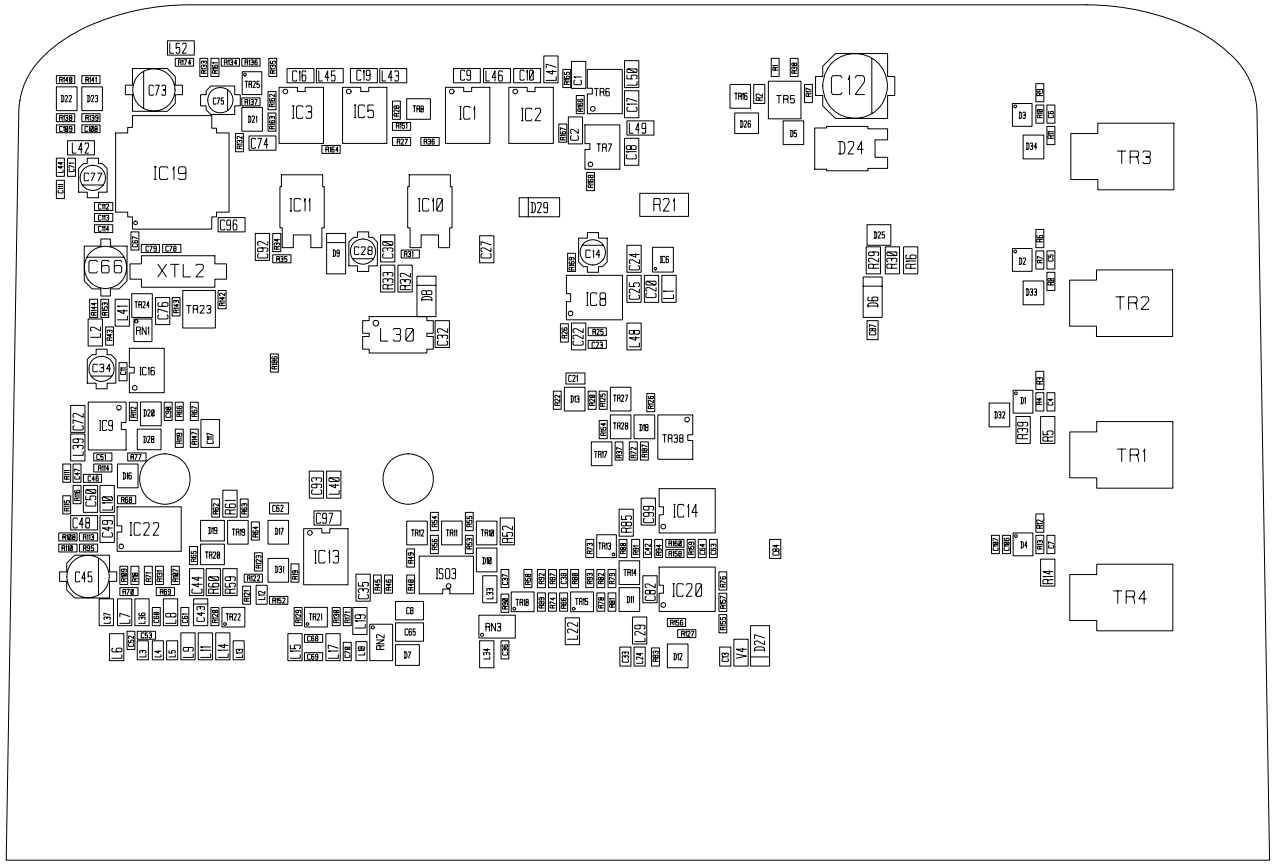
Diagrams

Drawing Number	Title (S1 & S1G)
4538001G - SHT 1	Mini Course Computer (surface mount component side)
4538001G - SHT 2	Mini Course Computer (conventional component side)
4538002Q - SHT 1	Mini Course Computer PSU/H - Bridge
4538002Q - SHT 2	Mini Course Computer NMEA/SeaTalk
4538002Q - SHT 3	Mini Course Computer Fluxgate/Rate Gyro
4538002Q - SHT 4	Mini Course Computer Micro

Drawing Number	Title (S0 &S0G Tiller & Wheel Pilot)
4630002a - SHT 1	S0 Mini Course Computer PSU/H - Bridge
4630002a - SHT 2	S0 Mini Course Computer NMEA/SeaTalk
4630002a - SHT 3	S0 Mini Course Computer Fluxgate/Rate Gyro
4630002a - SHT 4	S0 Mini Course Computer Micro

PCB 3015-286

SURFACE MOUNT COMPONENT SIDE



MODIFICATION/AMENDMENT		
ISS	DATE	COMMENTS
A	28.01.03	First Issue
B	27.05.03	Updated Issue
C	03.07.03	Updated to bring in line with sheet2.
D	10.07.03	Added Note for C14 polarity.
E	04.08.03	Deleted Note.
F	30.06.04	Deleted C95 (No fit). M-04-0105
G	29.07.05	C43 rotated 180° to correct polarity. M-05-0106

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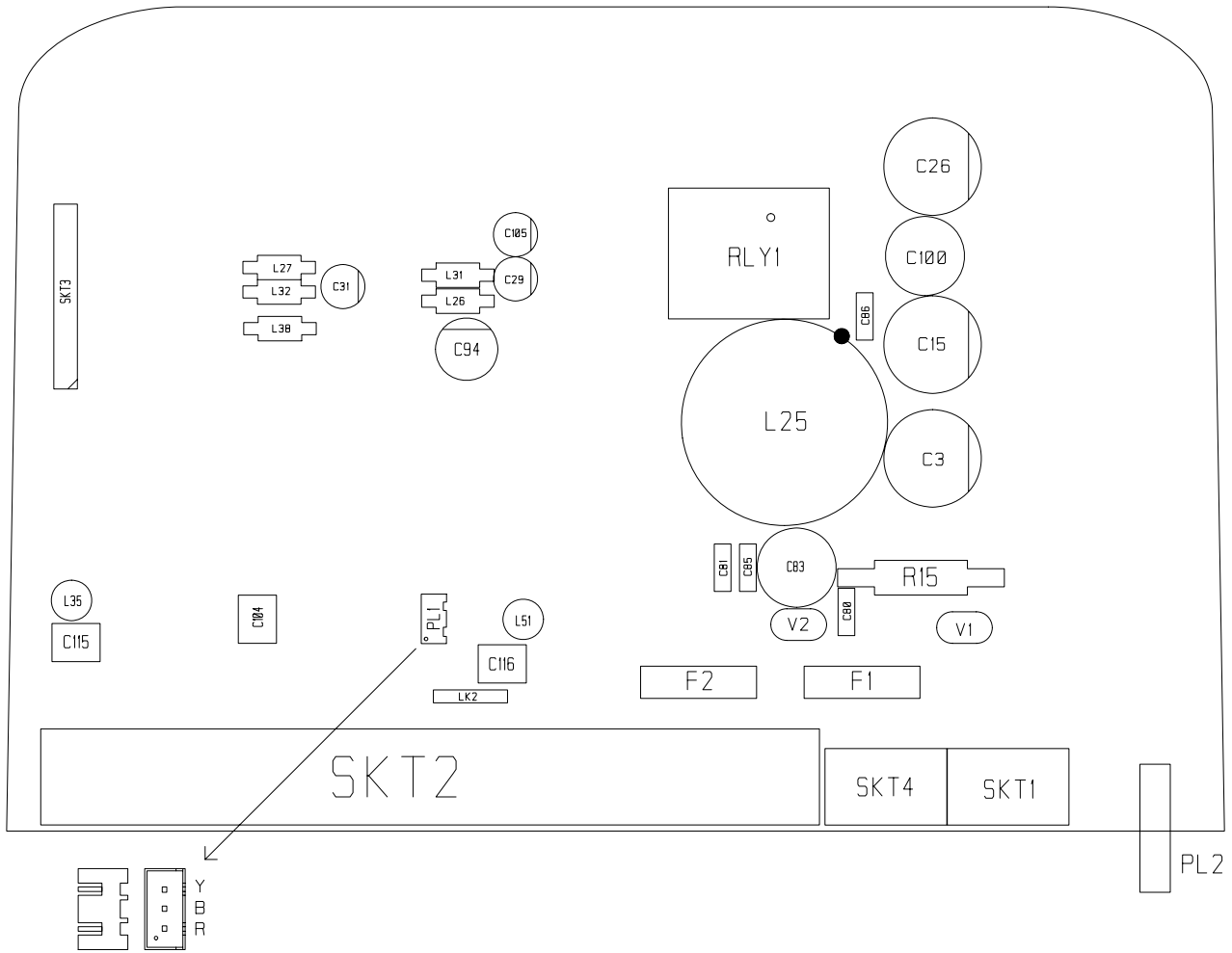
DO NOT SCALE	REMOVE ALL BURRS AND SHARP EDGES UNLESS OTHERWISE STATED	DRAWN SWJ	CHKD MW	DATE 28.01.03
PROJ D538	TITLE . MINI COURSE COMPUTER SHEET 1 OF 2	SCALE 1:1	DRWG No:- 4538-001	

PCB 3015-286

CONVENTIONAL COMPONENT SIDE



MODIFICATION/AMENDMENT

ISS	DATE	COMMENTS
A	28.01.03	First Issue
B	27.05.03	Updated Issue
C	03.07.03	Deleted L23 & Added LK2.
D	10.07.03	Upissued to bring in line with sheet 1.
E	04.08.03	Upissued to bring in line with sheet 1.
F	30.06.04	Upissued to bring in line with sheet 1. M-04-0105
G	29.07.05	Upissued to bring in line with sheet 1. M-05-0106

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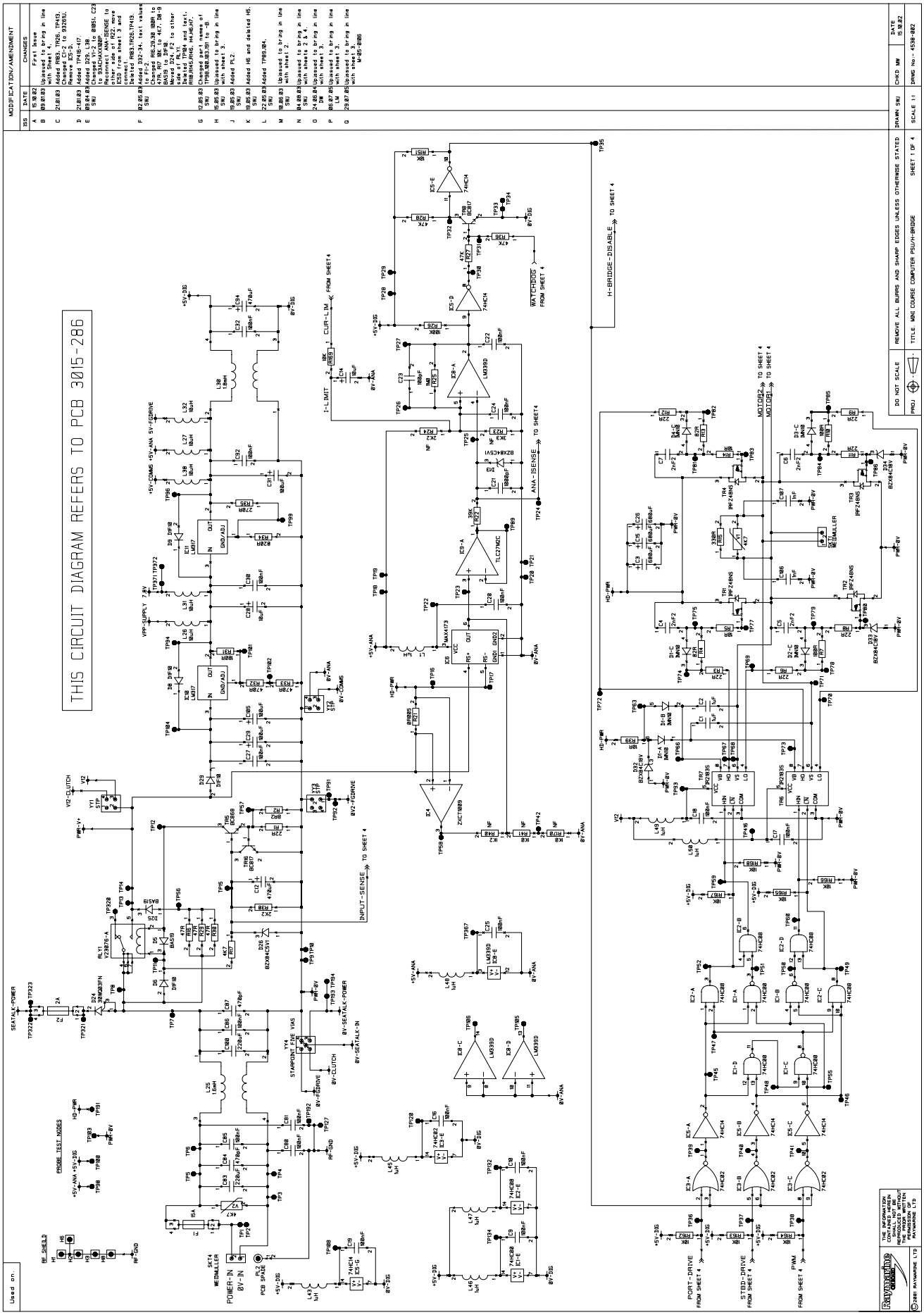
DO NOT SCALE	REMOVE ALL BURRS AND SHARP EDGES UNLESS OTHERWISE STATED	DRAWN SWJ	CHKD MW	DATE 28.01.03
PROJ D538	TITLE . MINI COURSE COMPUTER SHEET 2 OF 2	SCALE 1:1	DRWG No:- 4538-001	


THIS CIRCUIT DIAGRAM REFERS TO PCB 3015-286
MODIFICATION/AMENDMENT
ISS | DATE | CHANGES
A 15.10.82 First Issue
B 08.01.83 Upissued to bring in line with Sheet 4.
C 21.01.83 Added RB3, TP28, TP43. Changed C6 to 330pF. Remove IC5-D.
D 21.01.83 Added TP46-47.
E 28.01.83 Added IC9, L38. Changed IC6 to 8085. C23 to 33nMAX/330P. Reconnect ANA-SENSE to pin 1 and 2 of IC2. Add IC3-E. Delete IC5-E.
SW Changed R6 to 10K. Added TP48.
F 02.05.83 Added IC12-14, text values to P1-2. SW Changed R16,29,30 (680R to 470, R17 68K to 47K, R8-9 (BASIC) to 3P3. Moved TP42 to other side of RLY1. Changed R6 and text. R18,R45,R46, R47,R48,R7.
G 12.05.83 Changed part names of TP86,88,89,91 to -B. SW
H 15.05.83 Upissued to bring in line with sheet 3.
J 19.05.83 Added PL2. SW
K 19.05.83 Added H6 and deleted H5. SW
L 22.05.83 Added TP85,86. SW
M 30.05.83 Upissued to bring in line with sheet 2. SW
N 04.08.83 Upissued to bring in line with sheets 2 & 4. SW
O 24.08.84 Upissued to bring in line with sheet 3. SW
P 08.07.85 Upissued to bring in line with sheet 3. LM
Q 29.07.85 Upissued to bring in line with sheet 3. W-85-3086
DRAWN SW | CHKD WW | DATE 15.10.82
DRWG No - 4538-082
SCALE 1:1 | SHEET 1 OF 4
TITLE MINI COURSE COMPUTER PSU/H-BRIDGE
REMOVE ALL BURRS AND SHARP EDGES UNLESS OTHERWISE STATED
DO NOT SCALE
PROJ
H-BRIDGE-DISABLE TO SHEET 4
WATCHDOG FROM SHEET 4
I-L LIMIT
CUR-LIM FROM SHEET 4
ANA-ISENSE TO SHEET4
INPUT-SENSE TO SHEET 4
MOTOR2 TO SHEET 4
MOTOR1 TO SHEET 4
PORT-DRIVE FROM SHEET 4
STBD-DRIVE FROM SHEET 4
PWM FROM SHEET 4
POWER-IN 0V-IN
SEATALK-POWER
SEATALK-IN
PROBE TEST NODES
RF SHIELD
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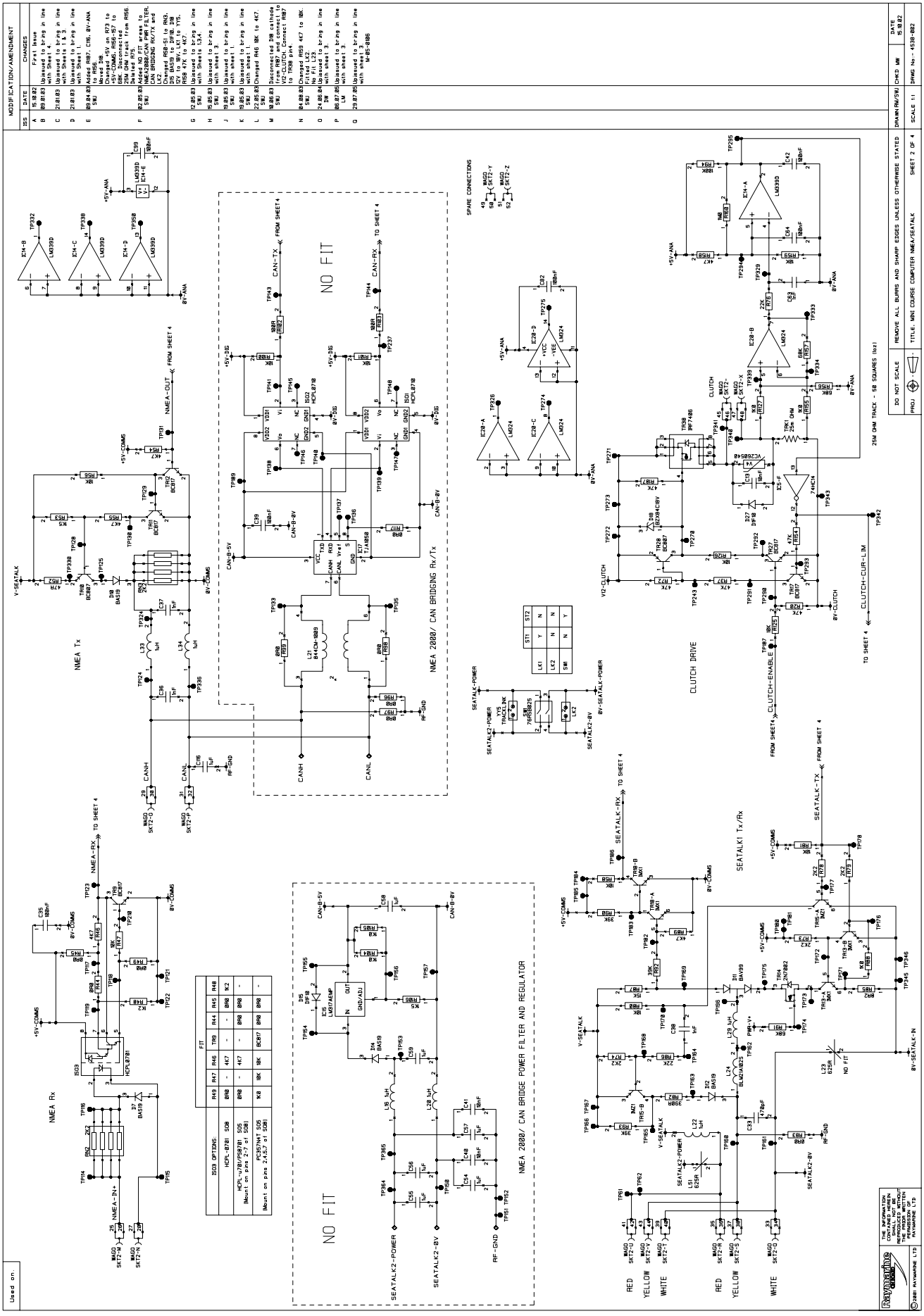
MODIFICATION/AMENDMENT
ISS DATE CHANGES
A 15.10.82 First Issue
B 09.01.83 Upissued to brpg in line with Sheet 4
C 21.01.83 Upissued to brpg in line with Sheets 1 & 3
D 21.01.83 Upissued to brpg in line with Sheet 1
E 08.04.83 Added R87, C86, 8V-ANA SW1 Added NO FIT wreap to CAN BRIDGING RX/TX and +5V-COMMS, R58-R57 to 68K. Disconnected 2SK1058 drain from R58. Deleted R75.
F 02.05.83 SW1 Added NO FIT wreap to CAN BRIDGING RX/TX and LK2. Changed R58-51 to RN3. D16 BA519 to DP18. D18 BA519 to 18V, LK1 to YYS. R58 to 47K, R57 to 47K.
G 12.05.83 SW1 Upissued to brpg in line with Sheets 1,3,4
H 15.05.83 SW1 Upissued to brpg in line with sheet 3
J 19.05.83 SW1 Upissued to brpg in line with sheet 1
K 19.05.83 SW1 Upissued to brpg in line with sheet 1
L 23.05.83 SW1 Changed R46 18K to 47K.
M 10.06.83 SW1 Disconnected D18 cathode from R87, and connect to VCC. Connect R87 to TR38 pink.
N 04.08.83 SW1 Changed R59 47K to 18K. Fitted LK2
O 24.08.84 DW Upissued to brpg in line with sheet 3.
P 06.07.85 SW1 Upissued to brpg in line with sheet 2
Q 23.07.85 SW1 Upissued to brpg in line with sheet 3
M-05-0186
DRAWN/RW/SW1
CHK'D MM
DATE 15.10.82
DRWG No - 4538-082
SCALE 1:1
SHEET 2 OF 4
DO NOT SCALE
REMOVE ALL BURRS AND SHARP EDGES UNLESS OTHERWISE STATED
PROJ
TITLE: MINI COURSE COMPUTER NMEA/SEATALK
25M OHM TRACK - 58 SQUARES (oz)
NMEA Tx
NMEA Rx
NMEA 2000/ CAN BRIDGING Rx/Tx
CLUTCH DRIVE
SEATALK Tx/Rx
NMEA 2000/ CAN BRIDGE POWER FILTER AND REGULATOR
SPARE CONNECTIONS
NO FIT
FIT
ISO3 OPTIONS
HCPL-0701 SO8
HCPL-072/0720/0731 SO5
Mount on pins 2+7 of SO81
PC357N4T SO5
Mount on pins 2,4,5,7 of SO81
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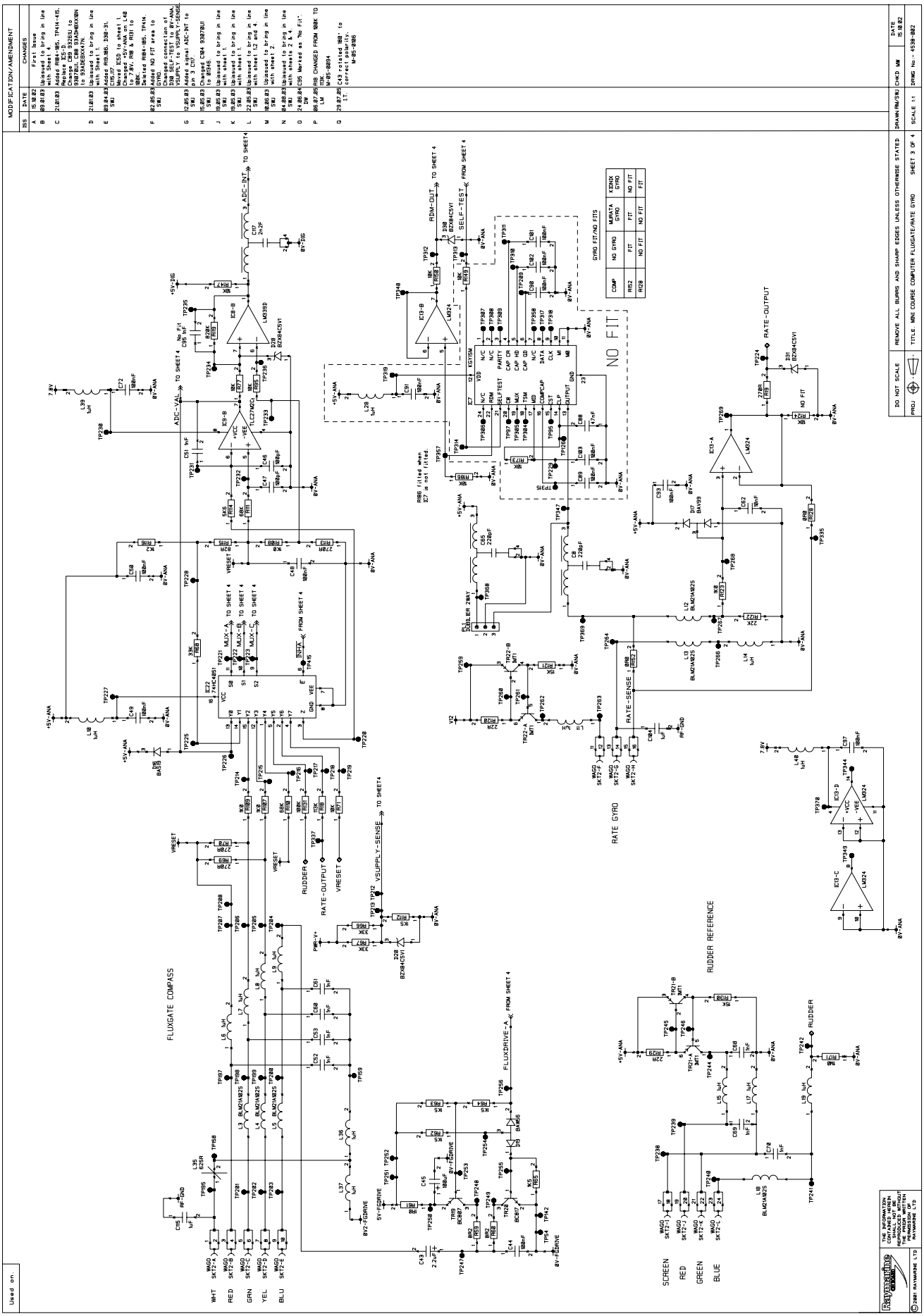
RED
YELLOW
WHITE
CANH
CANL
SEATALK2-POWER
SEATALK2-0V
RF-GND
V-SEATALK
8V-SEATALK-IN
CLUTCH-ENABLE
CLUTCH-CUR-LIM
V2-CLUTCH
8V-CLUTCH
CAN-TX
CAN-RX
SEATALK-TX
SEATALK-RX
NMEA-OUT
NMEA-RX
NMEA-IN+
NMEA-IN-
+5V-COMMS
8V-COMMS
+5V-ANA
8V-ANA
+5V-DIG
8V-DIG
CAN-B-5V
CAN-B-8V
SEATALK-POWER
SEATALK2-8V
8V-SEATALK-POWER
FROM SHEET 4
TO SHEET 4


MODIFICATION/AMENDMENT RECORD
DESCRIPTION OF CHANGES
DRAWN/RM/SW
CHK'D MM
DATE 15.10.82
DRWG No.- 4538-882
SCALE 1:1
SHEET 3 OF 4
TITLE MINI COURSE COMPUTER FLUXGATE/RATE GYRO
DO NOT SCALE
REMOVE ALL BURRS AND SHARP EDGES UNLESS OTHERWISE STATED
PROJ
Used on:
WHT RED GRN YEL BLU
SCREEN RED GREEN BLUE
FLUXGATE COMPASS
RATE GYRO
RUDDER REFERENCE
RATE-OUTPUT
RUDDER
VRESET
GYRO FIT/NO FITS
COMP NO GYRO MURATA GYRO KDNIX GYRO
RS2 FIT FIT NO FIT
RG2 NO FIT NO FIT FIT
NO FIT
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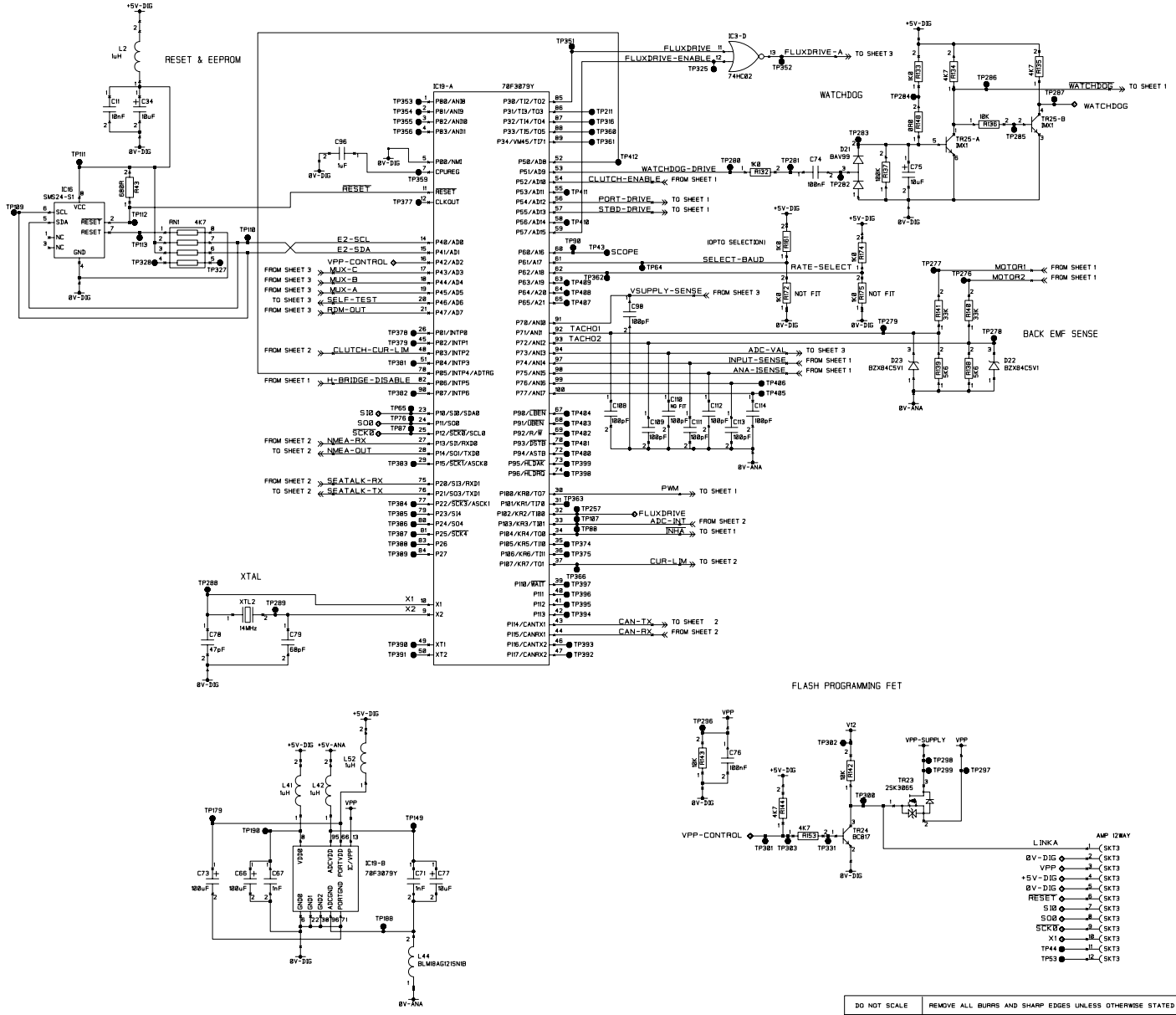

MODIFICATION/AMENDMENT		
ISS	DATE	CHANGES
A	15.10.02	First Issue
B	09.01.03	Add R176-182, TP187,257,258, 351-356,359,363,366,374-375,377-412,88,98.
C	21.01.03	Upissued to bring in line with Sheets 1 & 3.
D	21.01.03	Upissued to bring in line with Sheet 1.
E	09.04.03 SWJ	Added C96,98,108-114, L52. Changed SKT3 pin 3 to VPP, IC19a CLUTCH-CUR-LIM pin78 to pin48, L44 to BLM18AG121SN1D. Connect IC19a pin 78 to pin 52. Deleted TP388.
F	02.05.03 SWJ	Changed R172,175,C110 to NO FIT, C78 12P to 47P, C79 12P to 68P. Delete R176-182, TP89-98, 258,265,373,376.
G	12.05.03 SWJ	Changed part name of TP43 to -B.
H	15.05.03 SWJ	Upissued to bring in line with sheet 3.
J	19.05.03 SWJ	Upissued to bring in line with sheet 1.
K	19.05.03 SWJ	Upissued to bring in line with sheet 1.
L	22.05.03 SWJ	Added TP98.
M	18.06.03 SWJ	Upissued to bring in line with sheet 2.
N	04.08.03 SWJ	Upissued to bring in line with sheet 2.
O	24.06.04 DW	Upissued to bring in line with sheet 3.
P	05.07.05 LM	Upissued to bring in line with sheet 3.
Q	29.07.05	Upissued to bring in line with sheet 3. W-05-0106

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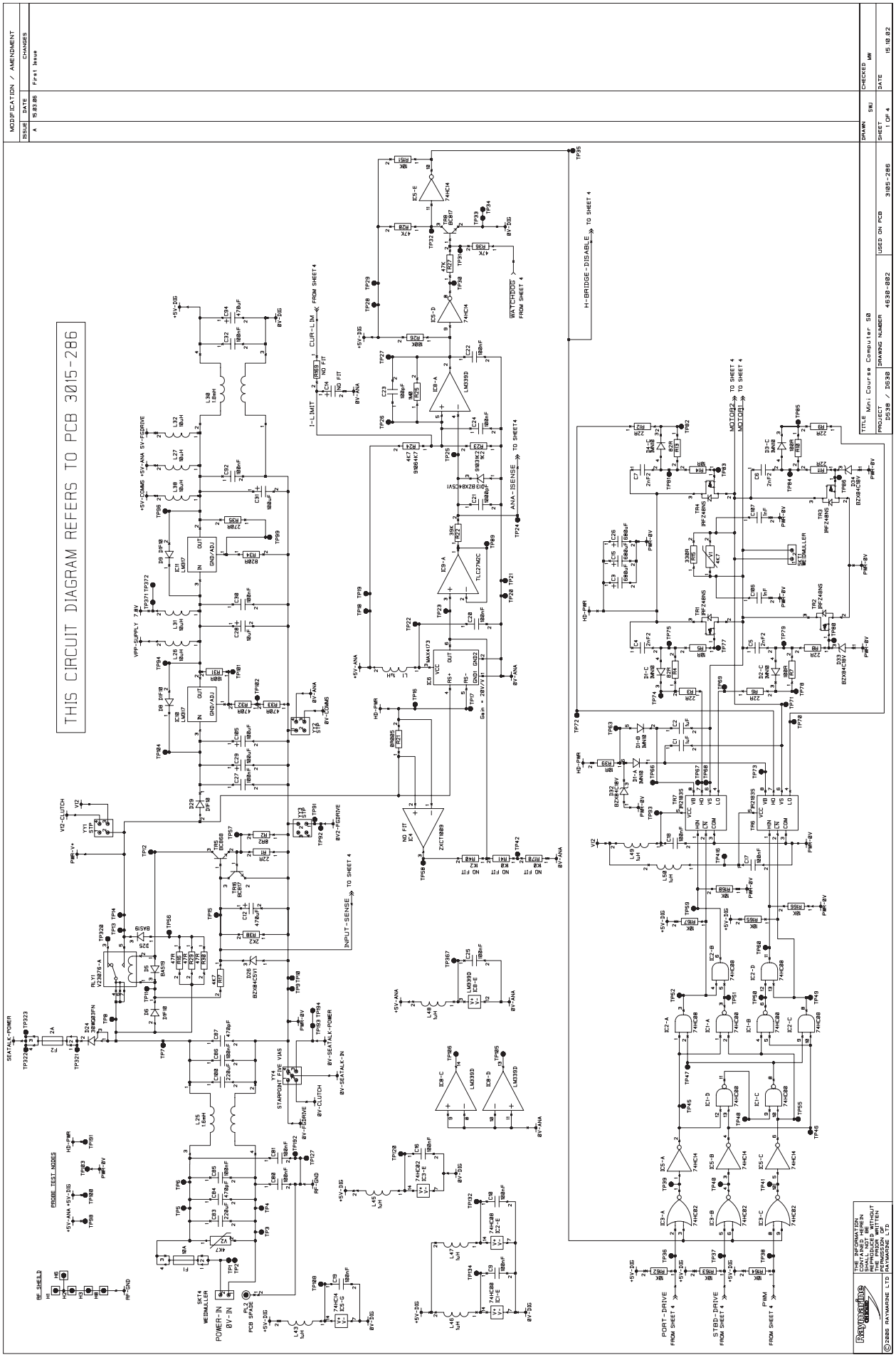
DO NOT SCALE	REMOVE ALL BURRS AND SHARP EDGES UNLESS OTHERWISE STATED	DRAWN RM/SWJ	CHKD MW	DATE 15.10.02
PROJ	TITLE MINI COURSE COMPUTER MICRO SHEET 4 OF 4	SCALE 1:1	DRWG No:- 4538-002	


THIS CIRCUIT DIAGRAM REFERS TO PCB 3015-286
MODIFICATION / AMENDMENT
ISSUE DATE CHANGES
A 15.03.06 First Issue
DRAWN SWJ CHECKED MW
SHEET 1 OF 4 DATE 15.10.02
TITLE Mini Course Computer S8
PROJECT D538 / D638 DRAWING NUMBER 4638-002 USED ON PCB 3185-286
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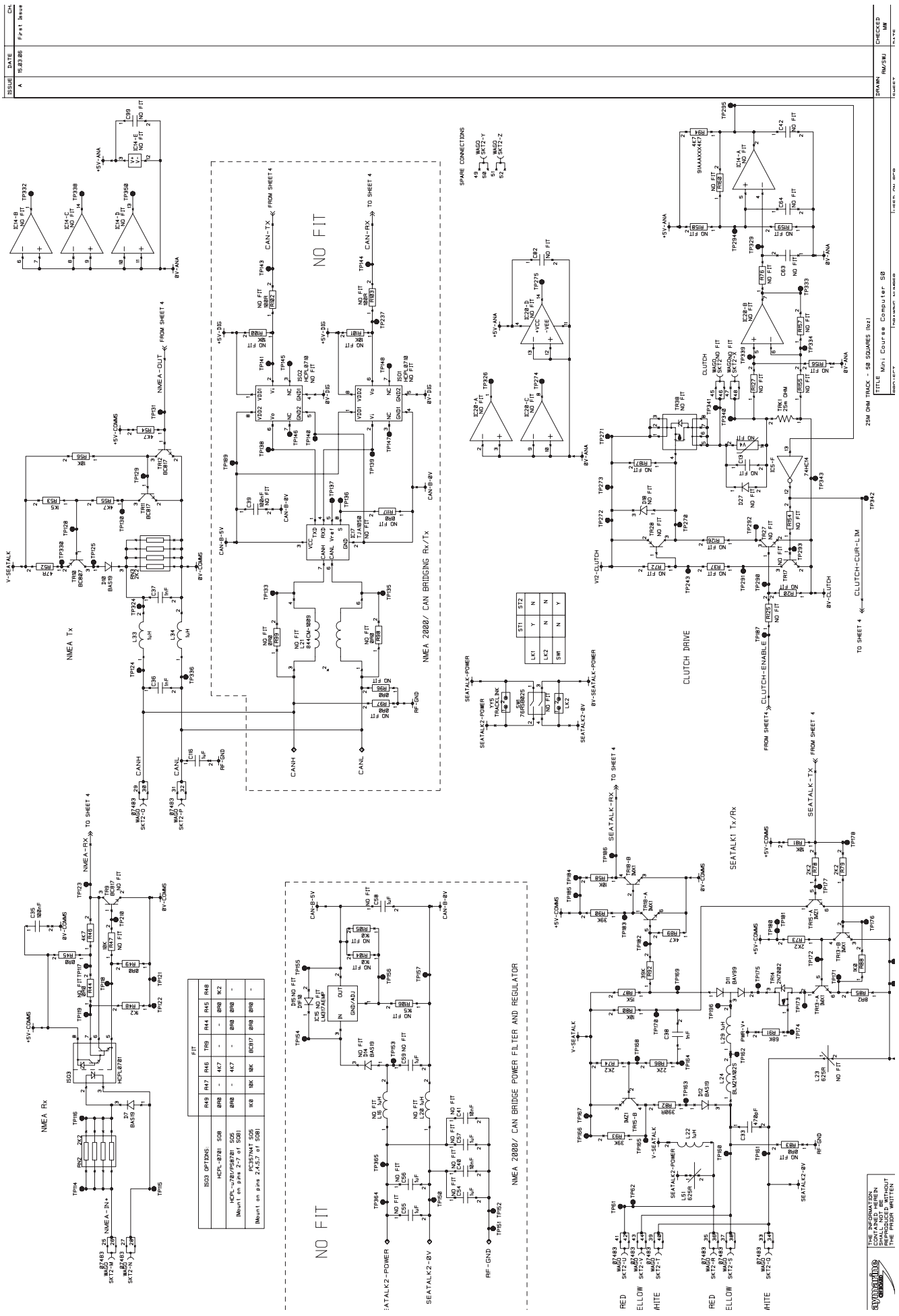
POWER-IN 0V-IN
PCB SPADE
SEATALK-POWER
PROBE TEST NODES
INPUT-SENSE
TO SHEET 4
FROM SHEET 4
I-LIMIT
CUR-LIM
ANA-ISENSE
WATCHDOG
H-BRIDGE-DISABLE
MOTOR1
MOTOR2
PORT-DRIVE
STBD-DRIVE
PWM
V2-CLUTCH
V2-FBDRIVE
STARPOINT-VIA
0V-SEATALK-IN
0V-SEATALK-POWER
0V-CLUTCH
0V-FBDRIVE
0V-COMMS
0V-ANA
0V-DIG
+5V-DIG
+5V-ANA
+5V-COMMS
+5V-ANA 5V-FBDRIVE
VPP-SUPPLY 7.8V
PWR-8V
HD-PWR
RF-GND
NO FIT
Gain = 20V/V
RAYMARINE


NMEA Tx
NMEA Rx
NMEA 2000/ CAN BRIDGING Rx/Tx
SEATALK1 Tx/Rx
CLUTCH DRIVE
NMEA 2000/ CAN BRIDGE POWER FILTER AND REGULATOR
NO FIT
V-SEATALK
NMEA-OUT
NMEA-IN
CAN-TX
CAN-RX
SEATALK-TX
SEATALK-RX
CLUTCH-ENABLE
CLUTCH-CUR-LIM
SEATALK-POWER
SEATALK2-POWER
SEATALK2-0V
RF-GND
CANH
CANL
RED
YELLOW
WHITE
TITLE Mini Course Computer S8
25M OHM TRACK - 58 SQUARES (loz)
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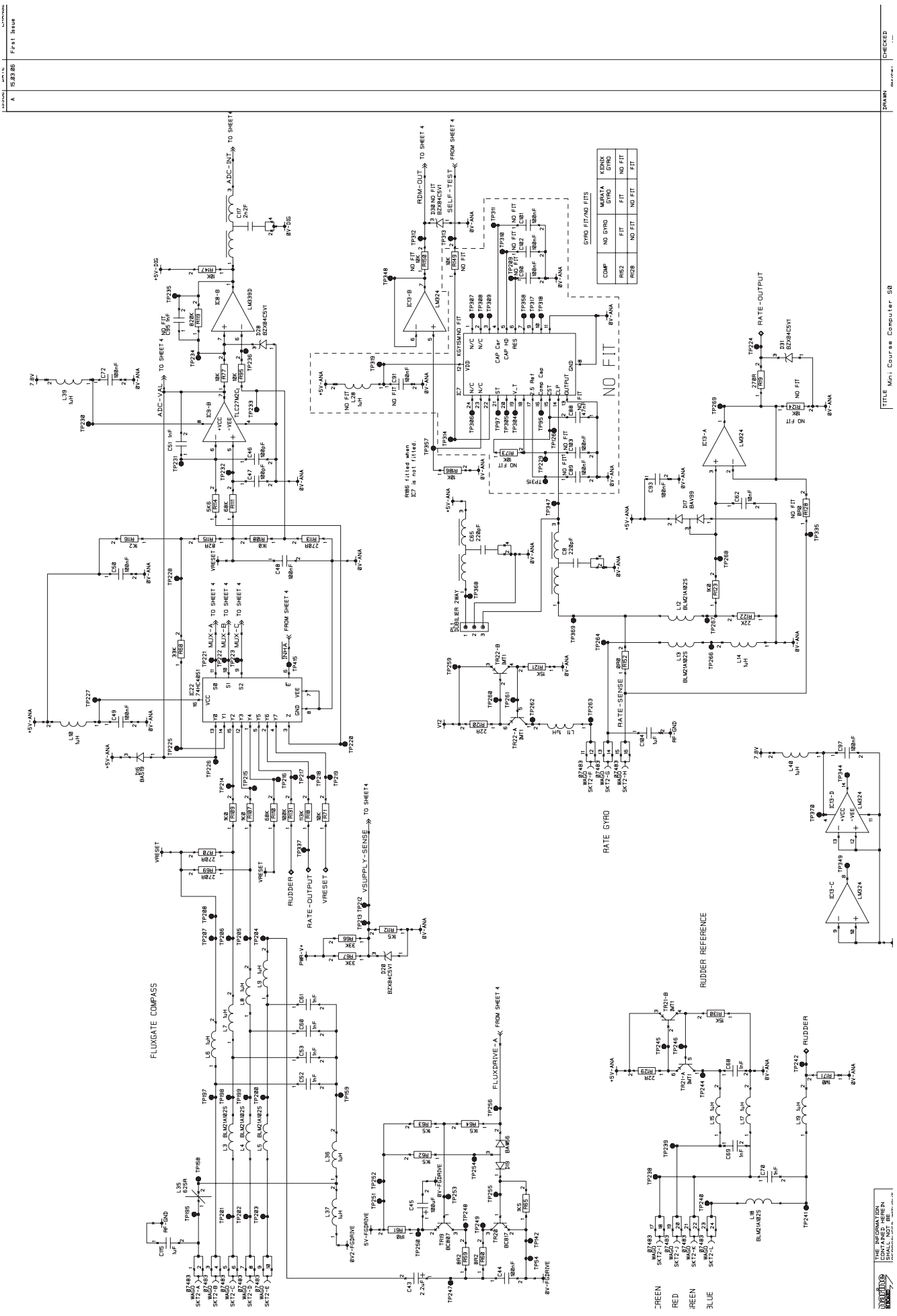
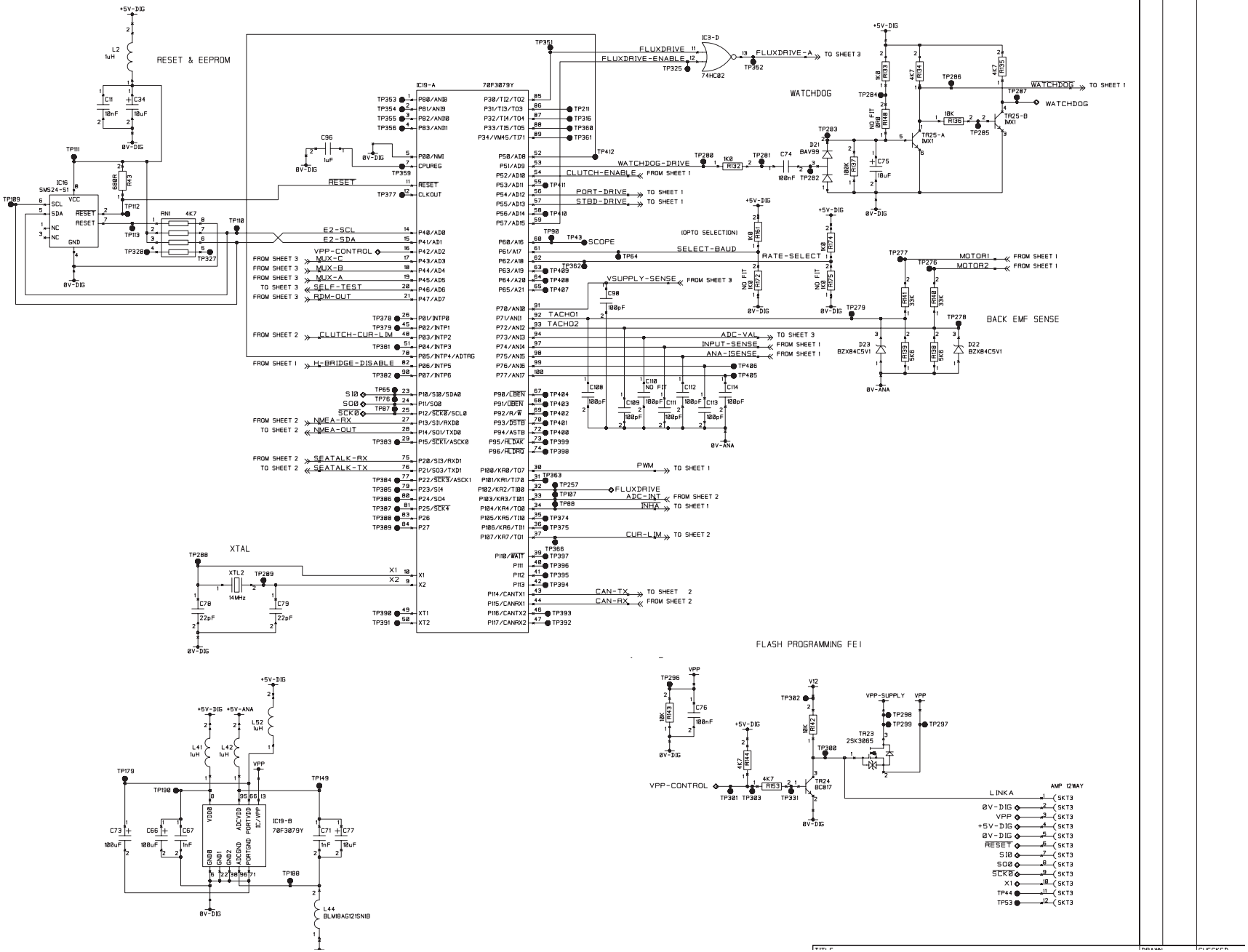

FLUXGATE COMPASS
RATE GYRO
RUDDER REFERENCE
ADC-VAL
ADC-INT
RATE-OUTPUT
RUDDER
VRESET
VSUPPLY-SENSE
FLUXDRIVE-A
RATE-SENSE
PWR-V+
NO FIT
TITLE Mini Course Computer S0
DRAWN
CHECKED
First Issue
THE INFORMATION CONTAINED HEREIN SHALL NOT BE


RESET & EEPROM
WATCHDOG
XTAL
FLASH PROGRAMMING FEI
BACK EMF SENSE
74HC02
IC19-A
IC19-B
70F3079Y
SMS24-S1
TO SHEET 1
TO SHEET 2
TO SHEET 3
FROM SHEET 1
FROM SHEET 2
FROM SHEET 3
FLUXDRIVE
FLUXDRIVE-ENABLE
FLUXDRIVE-A
WATCHDOG-DRIVE
CLUTCH-ENABLE
PORT-DRIVE
STBD-DRIVE
SCOPE
SELECT-BAUD
RATE-SELECT
VSUPPLY-SENSE
TACHO1
TACHO2
ADC-VAL
INPUT-SENSE
ANA-ISENSE
PWM
ADC-INT
INHA
CUR-LIM
CAN-TX
CAN-RX
E2-SCL
E2-SDA
VPP-CONTROL
MUX-C
MUX-B
MUX-A
SELF-TEST
ROM-OUT
CLUTCH-CUR-LIM
H-BRIDGE-DISABLE
NMEA-RX
NMEA-OUT
SEATALK-RX
SEATALK-TX
RESET
CPUREG
CLKOUT
MOTOR1
MOTOR2
LINKA
AMP 12WAY
+5V-DIG
+5V-ANA
0V-DIG
0V-ANA
VPP
VI2
XTL2
14MHz

Parts list S1 &S1G

Applicable to S1 & S1G Pilot

Description	Ref Des
VARISTOR TYPE GE V22ZT1	V1,V2
RES. 330R(ROX3S 330R)	R15
CAP ELECT 470uF 25V RADIAL	C94
CAP. 100NF 100V	C80,C81,C85,C86
CAP. 680uF, 50V RADIAL	C3,C15,C26
CAP 100uF 25V +/- 20%	C29,C31,C105
CAP 1uF 63V PEST	C115,C104,C116
CAPACITOR 220uF ELECT 50V 20%	C83,C100
1 x 12 WAY HEADER - AMP	SKT3
PCB CONNECTOR(DBC 2 2.5 3 T)	PL1
WAGO CONNECTOR BLOCK(24 WAY)	SKT2
POWER CONNECTOR(10A)	SKT1,SKT4
RF GROUND TAG	PL2
24 SWG WIRE LINKS BANDLIER	LK2
INDUCTOR - EC24-100K	L26,L27,L31,L32,L38
AUTOMOTIVE FUSE CLIP	F1,F1,F2,F2
FERRITE(294666631)	L35,L51
CLOSED FRAME RELAY(V23076A)	RLY1
AUTOMOTIVE FUSE - 15 AMP	
AUTOMOTIVE FUSE - 2 AMP	
COMM. MODE CHOKE(10AMP)	L25
ZERO OHM LINK, 0603 PACKAGE	R45,R49,R152
RESISTOR 8R2+-5% 0805 0.1W	R2
RESISTOR 10R, 1206	R5,R14,R39
RESISTOR 1R0, 1206 0.25W	R61
RESISTOR 470R, 1206	R32,R33
RESISTOR 47R, 1206	R52,R16,R29,R30
RESISTOR 8R2, 1206	R59,R60,R85
TRANSGUARD	V4
RES. NETWORK 2K2(MNR34)	RN2,RN3
RESISTOR NETWORK	RN1
RES. 100K, 1%, 0.063W, 0603	R26,R94,R131,R137
RES. 100R, 1%, 0.063W, 0603	R7,R10
RES 113K 1% 0603	R18
RESISTOR 180R 1% 0.063W	R31

Applicable to S1 & S1G Pilot

Description	Ref Des
Res 1K07 0603	
Res 200R 0603	R113
RES. 270R, 1%, 0.063W, 0603	R35,R69,R70,R19,R19
RES. 390R, 1%, 0.063W, 0603	R82
RESISTOR - 680 OHMS 1% 0603	R43
RESISTOR - 820K 1% 0603	R119
RES. 820R, 1%, 0.63W, 0603	R34
RESISTOR 10K,1% 0.063W 0603	R56,R58,R71,R77,R80,R81,R95,R125,R126,R136,R142,R143,R147,R151,R162,R163,R164,R165,R166,R167,R168,R169,R186,R159
RESISTOR 15K 1% 0.063W 0603	R87,R121,R130
RESISTOR 1.0K,1% 0.063W 0603	R88,R107,R109,R123,R127,R132,R133,R155,R161,R174,R174
RESISTOR - 1K2 1% 0603	R48,R116
RESISTOR 1.5K,1% 0.063W 0603	R53,R62,R63,R64,R65,R112
RES. 22K,1%,0.063W,0603	R76,R86,R122
RESISTOR 22R 1% 0.063W 0603	R1,R3,R6,R8,R9,R11,R12,R120,R129
RESISTOR 2.2K,1% 0.063W 0603	R38,R73,R74,R78,R79
RESISTOR 33K,0.063W,0603	R66,R67,R68,R140,R141
RESISTOR 39K,1% 0.063W 0603	R22,R90,R92,R93
RESISTOR 47K,1% 0.063W 0603	R20,R27,R28,R36,R37,R72,R154,R187
RESISTOR 4.7K,1% 0.063W 0603	R46,R54,R55,R89,R134,R135,R144,R153,R158,R17
RESISTOR - 5K6 1% 0603	R114,R138,R139
RESISTOR 68K,1% 0.063W 0603	R91,R110,R111,R156,R157
RESISTOR - 82 OHMS 1% 0603	R4,R13,R115
RESISTOR 1M,1% 0.063W 0603	R25,R160,R171
CHIP RESISTOR - LR2512	R21
SCHOTTKY RECTIFIER(30WQ03FN)	D24
DIODE SOT23 BAS19	D5,D7,D10,D12,D16,D25
BAV99 DIODE	D11,D17,D21
BAW56LT1 DIODE	D19
BZX84C18 ZENER DIODE	D18,D32,D33,D34
5V1 ZENER	D13,D20,D22,D23,D26,D28,D31
DIODE RECTIFIER 1A / 100V	D6,D27,D29,D8,D9
TRIPLE DIODE ARRAY - ISOLATED	D1,D2,D3,D4
CAPACITOR 470pf 100v +-5% 0805	C33,C84,C87
CAPACITOR 0.01uF, X7R	C13,C62
CAPACITOR 1000pF, 0805	C21

Applicable to S1 & S1G Pilot

Description	Ref Des
CAPACITOR 0.1uF, 1206	C9,C10,C16,C17,C18,C19,C20,C22,C24,C25,C27,C30,C32,C35,C44,C48,C49,C50,C72,C74,C76,C82,C92,C93,C97,C99
CAPACITOR 2.2uF	C43
CAPACITOR 100uF ELECT. 6.3VDC	C45,C66,C73
CAPACITOR 10uF, 16VDC ELECT	C14,C28,C34,C75,C77
CAPACITOR Y5V 1206 1uF 50V	C1,C2,C96
CAP. SM,100pF,50V,5%,0603	C46,C47,C108,C98,C109,C111,C112,C113,C114,C23
CAP. SM,22pF,50V,5%,0603	C78,C79
CAP. 10nF XR7	C11
CAPACITOR 1nF 0603	C36,C37,C38,C51,C52,C53,C60,C61,C63,C67,C68,C69,C70,C71,C106,C107
CAPACITOR 2.2nF 0603	C4,C5,C6,C7
CAPACITOR 100nF, 0603	C42,C64
CAPACITOR 470uF 10V +/-20%	C12
CAPACITOR 220pF 25V -20/+50%	C8,C65
CAP. SM 2.2nF 25V 1206	C117
RESET CONTROLLER S24O22 +2KMEM	IC16
FLASH MICRO(uPD70F3079)	IC19
QUAD 2 INPUT NAND	IC1
QUAD NOR 74HC02	IC3
QUAD AND GATE - SN74HC08D R	IC2
SCHMITT TRIGGER IC	IC5
IC 74HC4051	IC22
OPTO SWITCH - HCPL-0701	ISO3
HALF-BRIDGE DRIVER	TR6,TR7
MOSFET(IRF7406TR) - POWER FET	TR38
QUAD OP-AMP LM324	IC13,IC20
QUAD COMPARATOR	IC8,IC14
CURRENT SENSE AMP.(MAX4173)	IC6
TLC27M2CD	IC9
VOLT. REG. - LM317MDT	IC10,IC11
2N7002 MOSFET	TR14
SWITCHING MOSFET(N-CHANNEL)	TR23
BC807	TR10,TR19,TR28
BC817	TR8,TR11,TR12,TR16,TR17,TR20,TR24,TR27
DUAL TRANSISTOR ARRAY	TR21,TR22
DIGITAL TRANSISTOR ARRAY	TR13,TR18,TR25

Applicable to S1 & S1G Pilot

Description	Ref Des
DUAL TRANSISTOR ARRAY	TR15
SM FET(IRFZ48NS)	TR1,TR2,TR3,TR4
EC868	TR5
INDUCTOR 5A COMMON MODE	L30
14.0MHz CRYSTAL(HC49/4HSMX)	XTL2
CHIP FERRITE BEAD BLM21 SERIES	L3,L4,L5,L12,L13,L18,L24
CHIP INDUCTOR	L1,L2,L6,L7,L8,L9,L10,L11,L14,L15,L17,L19,L22,L29,L33,L34,L36,L37,L39,L40,L41,L42,L43,L45,L46,L47,L48,L49,L50,L52
CHIP INDUCTOR(BLM18AG121SN1D)	L44

Parts list S0 & S0G Tiller & Wheel

Description	Ref Des
VARISTOR TYPE GE V22ZT1	V1,V2
RES. 330R(ROX3S 330R)	R15
CAP ELECT 470uF 25V RADIAL	C94
CAP. 100NF 100V	C80,C81,C85,C86
CAP. 680uF, 50V RADIAL	C3,C15,C26
CAP 100uF 25V +/- 20%	C29,C31,C105
CAP 1uF 63V PEST	C115,C104,C116
CAPACITOR 220uF ELECT 50V 20%	C83,C100
1 x 12 WAY HEADER - AMP	SKT3
PCB CONNECTOR(DBC 2 2.5 3 T)	PL1
POWER CONNECTOR(10A)	SKT1,SKT4
RF GROUND TAG	PL2
22 WAY WAGO CONNECTOR	SKT2
24 SWG WIRE LINKS BANDLIER	LK2
INDUCTOR - EC24-100K	L26,L27,L31,L32,L38
AUTOMOTIVE FUSE CLIP	F1,F1,F2,F2
FERRITE(294666631)	L35,L51
CLOSED FRAME RELAY(V23076A)	RLY1
AUTOMOTIVE FUSE - 2 AMP	F2
10A FUSE	F1
COMM. MODE CHOKE(10AMP)	L25
ZERO OHM LINK, 0603 PACKAGE	R45,R49,R152
RESISTOR 8R2+-5% 0805 0.1W	R2
RESISTOR 10R, 1206	R5,R14,R39
RESISTOR 1K2 1206	R23
RESISTOR 1R0, 1206 0.25W	R61
RESISTOR 470R, 1206	R32,R33
RESISTOR 47R, 1206	R52,R16,R29,R30
RESISTOR 4K7, 1206	R24
RESISTOR 8R2, 1206	R59,R60,R85
RES. NETWORK 2K2(MNR34)	RN2,RN3
RESISTOR NETWORK	RN1
RES. 100K, 1%, 0.063W, 0603	R26,R131,R137
RES. 100R, 1%, 0.063W, 0603	R7,R10
RES 113K 1% 0603	R18
RESISTOR 180R 1% 0.063W	R31

Description	Ref Des
Res 1K07 0603	R108
Res 200R 0603	R113
RES. 270R, 1%, 0.063W, 0603	R35,R69,R70,R19,R19
RES. 390R, 1%, 0.063W, 0603	R82
RESISTOR - 680 OHMS 1% 0603	R43
RESISTOR - 820K 1% 0603	R119
RES. 820R, 1%, 0.63W, 0603	R34
RESISTOR 10K,1% 0.063W 0603	R56,R58,R71,R77,R80,R81,R95,R136,R142,R143,R147,R151,R162,R163,R164,R165,R166,R167,R168,R186
RESISTOR 15K 1% 0.063W 0603	R87,R121,R130
RESISTOR 1.0K,1% 0.063W 0603	R88,R107,R109,R123,R132,R133,R161,R174,R174
RESISTOR - 1K2 1% 0603	R48,R116
RESISTOR 1.5K,1% 0.063W 0603	R53,R62,R63,R64,R65,R112
RES. 22K,1%,0.063W,0603	R86,R122
RESISTOR 22R 1% 0.063W 0603	R1,R3,R6,R8,R9,R11,R12,R120,R129
RESISTOR 2.2K,1% 0.063W 0603	R38,R73,R74,R78,R79
RESISTOR 33K,0.063W,0603	R66,R67,R68,R140,R141
RESISTOR 39K,1% 0.063W 0603	R22,R90,R92,R93
RESISTOR 47K,1% 0.063W 0603	R27,R28,R36
RESISTOR 4.7K,1% 0.063W 0603	R46,R54,R55,R89,R94,R134,R135,R144,R153,R17
RESISTOR - 5K6 1% 0603	R114,R138,R139
RESISTOR 68K,1% 0.063W 0603	R91,R110,R111
RESISTOR - 82 OHMS 1% 0603	R4,R13,R115
RESISTOR 1M,1% 0.063W 0603	R25,R171
CHIP RESISTOR - LR2512	R21
SCHOTTKY RECTIFIER(30WQ03FN)	D24
DIODE SOT23 BAS19	D5,D7,D10,D12,D16,D25
BAV99 DIODE	D11,D17,D21
BAW56LT1 DIODE	D19
BZX84C18 ZENER DIODE	D32,D33,D34
5V1 ZENER	D13,D20,D22,D23,D26,D28,D31
DIODE RECTIFIER 1A / 100V	D6,D29,D8,D9
TRIPLE DIODE ARRAY - ISOLATED	D1,D2,D3,D4
CAPACITOR 470pf 100v +-5% 0805	C33,C84,C87
CAPACITOR 0.01uF, X7R	C62
CAPACITOR 1000pF, 0805	C21
CAPACITOR 0.1uF, 1206	C9,C10,C16,C17,C18,C19,C20,C22,C24,C25,C27,C30,C32,C35,C44,C48,C49,C50,C72,C74,C76,C92,C93,C97

Description	Ref Des
CAPACITOR 2.2uF	C43
CAPACITOR 100uF ELECT. 6.3VDC	C45,C66,C73
CAPACITOR 10uF, 16VDC ELECT	C28,C34,C75,C77
CAPACITOR Y5V 1206 1uF 50V	C1,C2,C96
CAP. SM,100pF,50V,5%,0603	C46,C47,C108,C98,C109,C111,C112,C113,C114,C23
CAP. SM,22pF,50V,5%,0603	C78,C79
CAP. 10nF XR7	C11
CAPACITOR 1nF 0603	C36,C37,C38,C51,C52,C53,C60,C61,C67,C68,C69,C70, C71,C106,C107
CAPACITOR 2.2nF 0603	C4,C5,C6,C7
CAPACITOR 470uF 10V +/-20%	C12
CAPACITOR 220pF 25V -20/+50%	C8,C65
CAP. SM 2.2nF 25V 1206	C117
RESET CONTROLLER S24O22 +2KMEM	IC16
FLASH MICRO(uPD70F3079)	IC19
QUAD 2 INPUT NAND	IC1
QUAD NOR 74HC02	IC3
QUAD AND GATE - SN74HC08D R	IC2
SCHMITT TRIGGER IC	IC5
IC 74HC4051	IC22
OPTO SWITCH - HCPL-0701	ISO3
HALF-BRIDGE DRIVER	TR6,TR7
QUAD OP-AMP LM324	IC13
QUAD COMPARATOR	IC8
CURRENT SENSE AMP.(MAX4173)	IC6
TLC27M2CD	IC9
VOLT. REG. - LM317MDT	IC10,IC11
2N7002 MOSFET	TR14
SWITCHING MOSFET(N-CHANNEL)	TR23
BC807	TR10,TR19
BC817	TR8,TR11,TR12,TR16,TR20,TR24
DUAL TRANSISTOR ARRAY	TR21,TR22
DIGITAL TRANSISTOR ARRAY	TR13,TR18,TR25
DUAL TRANSISTOR ARRAY	TR15
SM FET(IRFZ48NS)	TR1,TR2,TR3,TR4
EC868	TR5
INDUCTOR 5A COMMON MODE	L30
14.0MHz CRYSTAL(HC49/4HSMX)	XTL2

Description	Ref Des
CHIP FERRITE BEAD BLM21 SERIES	L3,L4,L5,L12,L13,L18,L24
CHIP INDUCTOR	L1,L2,L6,L7,L8,L9,L10,L11,L14,L15,L17,L19,L22,L29,L33,L34,L36,L37,L39,L40,L41,L42,L43,L45,L46,L47,L48,L49,L50,L52
CHIP INDUCTOR(BLM18AG121SN1D)	L44